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NATURE

A WEEKLY

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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THURSDAY, MAY 4, 1876

THE PROGRESS OF THE LOAN COLLECTION[1]

THE investigation of the nature of those forces by which the material world is ceaselessly being moved and transformed, enlists in our day the energies of a host of scientific workers. It would be hard, perhaps, to mention a department of natural science for the study of which a good knowledge of the fundamental principles of what we now term physics is not at least a valuable and indispensable qualification, if not indispensably required. To the geologist and the biologist, no less than to the astronomer and the chemist, will such knowledge be imperative. Considering the widespread ramification of this division of science, it is not wonderful that the apparatus belonging to it should occupy so large a share of the available space in the present collection.

The remark formerly made, that much of the interest awakened in this loan collection will centre in its historical element—in the primitive forms of apparatus that represent, in some sort, the germs of some great development of scientific thought—holds good for the departments of which we propose now to take a brief survey in continuation of our last week's article. On entering the room devoted to physics (exclusive of electricity and magnetism), attention is drawn to some aged-looking apparatus on the right. These are the celebrated original Magdeburg hemispheres of Otto von Guericke. They were exhibited by him in 1654 before the Princes of the Empire and the foreign ministers assembled at the Diet of Ratisbon. The force of two teams, each consisting of a dozen horses, made to pull in opposite directions (a portion of the rope is shown) was insufficient to separate the exhausted hemispheres. It was shortly after this date that the Burgomaster of Magdeburg heard of Torricelli's great discovery. The original air-pump of Otto von Guericke is also exhibited. It consisted of a globe of copper, with a stop-cock, to which a pump was fitted. The pump-barrel was entirely immersed in water to render it air-tight. The improvements in the air-pump by Boyle and Hooke, Papin, Hawksbee, and others, can be followed by the actual instruments they made. Among modern improved methods of producing a vacuum, is the pump of M. Deleuil, in which the pistons are solid cylinders of considerable length, without packing or lubricants, and not fitting tightly in the tubes. The internal friction of the air in the narrow space is so great that the rate at which it leaks into the exhausted part of the vessel, is not comparable with the rate at which the pump is exhausting air from the receiver. In the well known air-pump of Sprengel, air is drawn from the vessel to be exhausted into a vertical tube, through the descent of small successive portions of mercury in the latter. Thilorier's apparatus for liquefying carbonic acid, the apparatus used by Dr. Andrews in his researches on continuity of the gaseous and liquid states of matter, and a small model of M. Colladon's new air and gas compressor used for the St. Gothard tunnel, may also be noticed here.

The musical commencement of sound is generally put at about thirty-two (single) vibrations, and the upper limit of audition at about 73,000. Here will be found apparatus illustrating both extremes, including two organ pipes, the individual sounds of which are inaudible, but whose resultant tone or beat is within the limits of hearing. Helmholtz's double siren, and various other instruments connected with his invaluable researches on sound, will repay examination. Among musical instruments we may note some models of ancient Egyptian pipes, from the British Museum and that of Turin, an enharmonic harmonium, tuned according to the division of the octave into fifty-three equal intervals, and the first of the now generally adopted upright pianofortes patented by Robert Wornum in 1811. Mr. Baillie Hamilton contributes a series of apparatus illustrating very instructively the progress of the Æolian principle. The velocity of transmission of sound in water was experimented on by Colladon, on the lake of Geneva, in 1826, and again in 1841, and some of his apparatus is shown in the present section. With the long tube like a speaking trumpet, it is possible, in calm weather, at the distance of more than a hundred kilometres, to hear the strokes on a bell of half a ton weight immersed in the water. Once more, the apparatus is to

[1] Continued from vol. xiii. p. [illegible]

be seen by which Prof. Tyndall recently illustrated the reflection of sound by heated air or vapours; these, being made to stream up through six openings in the long chamber through which the sound is directed, are effectual in stopping its progress.

Of historical interest in the section of Light are some early stereoscopes, comprising that of Sir David Brewster; a camera-obscura said to have belonged to Sir Joshua Reynolds (which, when closed, has the form of a large folio leather-bound book), the original form of Brewster's kaleidoscope made by Bate, in 1815, the first heliostat, invented by Gravesande, &c. The vigour of the young science of spectroscopy is indicated by the fine array of instruments belonging to it, constructed by Steinheil, Browning, and others. There is shown the spectroscopic apparatus which Sir John Herschel used in photographing actions of different parts of the spectrum, and in his investigations on some supposed new elements. For illustrating the theoretical side of the subject of polarised light, various forms of instrument have been devised, the most comprehensive of which is known as the wave machine of Wheatstone; its object is to exhibit the results of the combination of various kinds of vibration meeting at various phases. Instruments based on the three different methods of producing plane polarisation are exhibited; and the various phases of rotatory and other polarisation can be shown simultaneously by means of an instrument which was invented independently by M. Mach and Mr. Spottiswoode. It is known that Wheatstone invented a "polar clock," based on the fact that the light from certain parts of the sky is polarised, and the plane of polarisation depends on the position of the sun; this is included in the collection. It would take too long to refer in detail to the now numerous varieties of photometric apparatus, or the apparatus for observing phosphorescence, fluorescence, and other phenomena connected with light. Several specimens exhibited of the enigmatical radiometers recently devised by Mr. Crookes will doubtless excite lively interest and speculation. In the photographic collection is the first known photograph on glass, taken on precipitated silver chloride by Sir J. Herschel; also the second daguerreotype obtained by Daguerre in 1839. The Woodbury and other processes are fully illustrated.

In the Heat department we cannot allow ourselves to linger at the fine collection of thermometric and other instruments. Among them is a milligrade thermometer, in which the interval between the freezing and boiling points of water is divided into one thousand degrees; it obviates the use of fractions. Wedgwood's pyrometer and Lavoisier's calorimeter are here; and many will feel interested in such apparatus as that by which Tyndall conducted researches on radiant heat, Regnault, De la Rive, and Marcet on the specific heat of gases, or Favre and Silbermann on the heat disengaged in combustion.

In the room devoted to Chemistry we come upon some old apparatus which is of the simplest and even the rudest character; it is a part of that with which John Dalton carried on his classical researches. Most of it was made with his own hands, and the articles here exhibited are chosen as illustrating this fact, and as indicating the genius which, with so insignificant an equipment, was able to produce such great results. The study of pneumatic chemistry was much advanced by the experiments of Black and Cavendish. Black showed that the difference between the caustic and mild alkalies was that the latter contained *fixed air*, a kind of air identical with that obtained from fermenting liquids. Cavendish pointed out the difference between inflammable air, which we now call hydrogen, and fixed air, now known as carbonic acid gas. Black's pneumatic trough and balance, and Cavendish's balance, are among the collection. The latter is rude in exterior but of singular perfection. Here, also, is the balance, belonging to the Royal Institution, which was used by Young, Davy, and Faraday. The researches of Faraday on the condensation and liquefaction of gases are well known, and one may here see the apparatus he employed, along with a number of the original tubes containing gases which he liquefied. Thomas Graham's apparatus, also exhibited, is remarkable, like that of Dalton, for the contrast between its simplicity and the great results that were achieved by means of it. The amateur or professional chemist will doubtless receive not a few happy hints in inspection of the large variety of apparatus connected with qualitative and quantitative analysis; and the comprehensive collection of chemicals contains many novelties. We further note some of the apparatus that Messrs. Lawes and Gilbert have used in their important researches in agricultural chemistry, and they exhibit a case of casts of white Silesian sugar-beet illustrating the influence of different manures on the amount of produce and on the percentages of dry matter and sugar in the roots. The great chemical industries of this country, in fine, are well represented by models of manufactories and by products.

Coming to Biology, we may notice first an interesting collection of old microscopes. Here is the silver microscope that was used by Anthony von Leeuwenhoek, the Dutch philosopher, and probably made by him; also the microscope used by Sir W. Hooker, in his description of the British Jungermanniеæ, &c. The microscopes of Dawson Turner, Robert Brown, Muschenbroek, and others, are also included. There is a compound microscope invented and constructed about the year 1590, by Jansens, the inventor of the telescope. This object, with its tin tube, is one of the most interesting things in the Collection. It is instructive to compare these instruments with their modern neighbours, of which there is a large variety.

The older physiologists obtained only qualitative results from their experiments; but the present generation has witnessed a remarkable advance in the application of instruments of precision to the quantitative determination of the effects of physiological processes. From this point of view a singular interest attaches to the muscle balance, constructed and used just forty years ago, by the eminent anatomist and physiologist who laid the foundations of animal histology. It is intended to demonstrate that muscular contraction takes place in accordance with the laws of elastic bodies, and it may be regarded as the first of the class of instruments referred to. The department contains a rich collection of such instruments; and no better illustration could be taken than the apparatus by which M. Marey has so successfully investigated the phenomena of animal locomotion and other physiological movements. The study of physiological optics has been

greatly cultivated in Germany, and the instruments connected with it (whose nomenclature, by the way, seems unusually bristling and difficult) offer many novel points for consideration. The mechanism of circulation and respiration in the animal subject is studied by means of a variety of delicate apparatus, and we note also some good schematic representations in which the movements are reproduced mechanically. The anatomist and histologist will find many beautifully prepared specimens from animal and plant life.

Leaving the biological section we enter that of geography, geology, and the allied sciences. Here the instruments used by the late Dr. Livingstone in his last journey possess a melancholy interest; they comprise a pocket chronometer, a sextant, hypsometrical boiling apparatus, and three thermometers. Specimens are shown of the dredging, sounding, and other apparatus that have been used on board the *Challenger*, the *Porcupine*, and other exploring vessels. The collection of maps is a large one; in it will be found a selection designed to illustrate the progress of cartography and surveying in India, the maps of the Geological Survey of this country, &c.; also the MS. maps of Livingstone, Burton and Speke, Baker, Stanley, and others. In a glass case may be observed several open log-books. One is Capt. Cook's log of the *Endeavour* in his voyage round the world (1768-71), another is that of one of his later voyages; another, the log of the proceedings of the *Bounty*, including an account of the mutiny. The subject of geology is largely illustrated by sections, maps, models, and specimens. We only note here the illustrations of the recent Sub-Wealden boring. There are numerous fine models in illustration of crystallography, and one of the goniometers exhibited is that of the Abbé Hauy. Among the objects connected with mining may be noted the apparatus constructed by Sir Humphrey Davy in his researches on the safety lamp.

The section of Applied Mechanics, which we have left to the last, might well claim a separate paper or a series of such. We can do no more than briefly refer to the collection of James Watt's models, which indicate, *e.g.*, the progress of his thoughtful labour in connection with the idea of separate condensers, and the expansive working of steam. In Watt's first engine great difficulty was experienced in fitting the piston accurately to the cylinder. Such difficulties exist no longer; and a remarkable example of the skill now attained in metallic constructions is afforded in the fine surface plate lent by Sir J. Whitworth; this is probably the closest approximation to an absolutely plane surface that has yet been realised. Finally, the old "Rocket" constructed by Stephenson in 1829, and the original engine of Henry Bell's steamboat, appear in this collection, the venerable quondam precursors of a great social revolution.

PREJEVALSKY'S MONGOLIA

Mongolia, the Tangut Country, and the Solitudes of Northern Tibet. By Lieut.-Colonel N. Prejevalsky, Translated by E. Delmar Morgan, F.R.G.S. With Introduction and Notes by Colonel Henry Yule, C.B. (Sampson Low and Co., 1876.)

WE have had occasion once or twice to refer briefly to Col. Prejevalsky's travels in Eastern High Asia, and some of our readers may have seen more or less detailed notices of his journey in the German and English geographical journals. These have been sufficient to show that the narrative of the Russian officer is of unusual value, and we are therefore thankful that not much time has been lost in making it accessible to the English public, to which Russian is practically an unknown tongue. The two volumes before us, however, contain only Col. Prejevalsky's general account of his expedition; and we regret that there seems to be no intention of making the special scientific results accessible to English readers. Judging from what is contained in the two volumes before us, these must be of the highest importance, and we hope that by some means they will be made known to English men of science.

The present translation has been brought out with great care. Mr. Delmar Morgan has put the narrative into clear and idiomatic English, which, we have reason to believe, faithfully represents the original Russian. He has, moreover, added to the value of the narrative for English readers by numerous supplementary and foot notes. We consider that both Col. Prejevalsky and the English reader are particularly fortunate in having the advantage of Col. Yule's knowledge to supplement and correct the original narrative. In an introduction he connects the journey of the Russian officer with those of previous explorers in Central and Eastern Asia, and especially with that of the well-known Huc and his companion Gabet. Considerable discredit has been thrown on the narrative of Huc, but Col. Yule shows that in the main it may be regarded as trustworthy, allowance being made for the missionary's love of exaggeration and his desire to produce effect. Prejevalsky's journey from Pekin to the south-west into Tibet coincided to some extent with that of Huc, and the former on several occasions impugns the accuracy, if not the veracity, of the latter. Those who are familiar with the old Abbé's delightful narrative will be glad to know that so great an authority as Col. Yule thinks that after all he is in the main trustworthy. Col. Yule's numerous notes will, moreover, be found to add much to the value of the work, both as supplementary to the main narrative and as corrective of occasional statements by Col. Prejevalsky arising from imperfect knowledge or rashness. This narrative Col. Yule shows, is an additional confirmation of the remarkable accuracy of that of Marco Polo.

The starting-point of Col. Prejevalsky's expedition was the town of Kiakhta, on the border of Siberia and Northern Mongolia, from which the small party set out in November, 1870, and returned to it after having done three years' hard and fruitful work, in October, 1873. The expedition seems to have been essentially a Government one, sent out at the instigation of the Russian Geographical Society. It is, therefore, difficult to understand how Col. Prejevalsky should have been so seriously hampered from want of sufficient funds. Yet so it was; the resources at the leader's command were a mere pittance as compared with the magnitude of the undertaking. The entire party consisted only of the Colonel, a companion, and two Cossacks, and the instrumental equipment was the most meagre possible. All things considered, it is marvellous that the results achieved were so many and so valuable. From Kiakhta the party went by Urga across the desert of Gobi, probably the dreariest desert in the world, to

Kalgan, and hence to Pekin. From Pekin a preliminary tour was made to the north, to Lake Dalai-nor, one object being to observe the spring flight of the birds of passage. This is a subject in which Col. Prejevalsky takes great interest, and throughout the whole extent of his journey he continued to make observations on the migrations of birds, and the present volumes contain many valuable notes on the subject. Lake Dalai-nor, which like many other lakes in this region, is salt, is described as a great rendezvous for migratory birds. The flight and habits of these birds are described fully in the more strictly scientific part of Col. Prejevalsky's account of the expedition, which is not included in the present translation. There is, however, a list of the various birds observed at this lake. In this, as in subsequent parts of his journey, Col. Prejevalsky noted as far as possible all the important features and products of the country as he proceeded. Surveying, however, was attended with many difficulties, on account of the suspicions of the natives, Chinese and Mongols, and it was only by stealth and by resorting to various artifices that Col. Prejevalsky could make use of his note-books. Another cause of difficulty and especially of delay was the insurrection of the Chinese Mohammedans, who had overrun and devastated much of the country through which Col. Prejevalsky's expedition passed.

On returning to Kalgan the expedition commenced the serious part of the undertaking, proceeding westwards by the In-shan Mountains, and crossing the Hoang-ho at Bauta, near the centre of its great northern bend. Proceeding along the left bank of the river through the country of the Ordos, the party recrossed the Hoang-ho at Ding-hu, into the Ala-shan country, and were well received by the prince at Din-yuan-ing. A number of days were spent here hunting and exploring among the Ala-shan mountains; but want of funds compelled the expedition to return to Kalgan. The return route was along the left side of the northern bend of the Hoang-ho, through the Khara-narin-ula mountains, where the cold experienced was quite Arctic. After staying a couple of months at Kalgan, the party again set out, this time fortunately much better equipped. They followed

Fig. 1.—The Gobi Plateau

pretty much the same route as on their return, until they again reached Din-yuan-ing, where their reception was by no means so hospitable as on the previous occasion. Fortunately they fell in here with a caravan of Tangutans bound for the Lama Monastery of Chobsen, within a short distance of Lake Koko-nor, the great goal of Col. Prejevalsky's efforts. After many attempts to prevent it on the part of the prince of Din-yuan-ing, the party set out with the Tangutan caravan, and, notwithstanding the country being overrun with the Dungans or Mohammedan rebels, Chobsen was safely reached. This monastery is about forty miles north of Sining-fu, on the south-western slope of the mountains bordering on the Tatung river, which lie to the north-east of Lake Koko-nor, and form part of the southern boundary of the Desert of Gobi. Among these mountains a considerable time was spent in hunting and making collections in natural history. The party "also investigated, *de visu*, for the first time it is believed in modern history, the famous rhubarb plant in its native region." The inadequacy of his means compelled Col. Prejevalsky reluctantly to give up the idea of penetrating as far as Lhassa. The basin of Lake Koko-nor was, however, explored, and the travellers pushed on to the south-west, through the region of Tsaidam, which is described as a vast salt-marsh covered with reeds, as if recently the bed of a great lake, and is said by the Chinese to stretch west and north to Lake Lob. Col. Prejevalsky proceeded as far as the lofty and uninhabited desert of Northern Tibet, turning at the upper stream of the great Yang-tse-Kiang, here called by the Mongols the Murui-ussu.

The party retraced their steps leisurely as far as Din-yuan-ing, where they arrived in a most worn and ragged condition. After a rest here they set out to attempt what was probably the most arduous part of their undertaking, the crossing of the heart of the great desert of Gobi from south to north, a feat never before attempted by any European. "This desert is so terrible, that in comparison with it the desert of Northern Tibet may be called fruitful. There, at all events, you may find water and good pasture-land in the valleys; here there is neither the one nor the other, not even a single oasis;

everywhere the silence of the Valley of Death." Kiakhta was reached on October 1, 1873.

Such is a very brief outline of the route traversed by the small expedition under Col. Prejevalsky. It gives no idea of the amount of work done, and the many difficulties which had to be overcome. Though the Colonel had a pass from the Chinese Government, it was not of much use to him. At almost every stage obstructions were thrown in his way, and had the party not been able to obtain a living by their guns they would either have had to starve or turn back. The whole distance traversed was upwards of 7,400 miles.

Col. Prejevalsky's object was not simply to get over a certain amount of ground. In many respects he is well qualified to conduct a scientific exploring expedition. Not only is he skilled in all kinds of surveying work necessary to map a country, but has evidently a good

FIG. 2 — Mongol Girl.

knowledge of geology, and is above all an accomplished zoologist and botanist. At every stage he stops to describe deliberately the natural features of the region, its inhabitants, its history, and to give long lists of the animals and plants collected. Some idea of the importance of the expedition from a scientific point of view may be learned from the fact that the plants collected amounted to 5,000 specimens, representing upwards of 500 species, of which a fifth are new. But especially important was the booty in zoology, which is Prejevalsky's own specialty, for this included thirty-seven large and ninety smaller mammals, 1,000 specimens of birds, embracing 300 species, 80 specimens of reptiles and fish, and 3,500 of insects.

It would be impossible within the space of a notice like the present to give any adequate idea of the kind and amount of information contained in these volumes. No such keen-sighted and accomplished traveller has been over the same ground before. We shall endeavour to indicate a few of the points referred to. In the Introduction, besides the matters already referred to, Col. Yule adduces strong proofs for the existence of the wild camel on the north-west borders of China, and gives a few valuable notes on the real nature of Tibetan Lamaism. The Gobi desert, both in its eastern and central positions, is at last described with something like adequacy; it is probably one of the dreariest tracks on the face of the earth. One of the strong features of the book is its ethnology; all the groups of people passed through are described in detail. A whole chapter is devoted to the Mongols, containing minute particulars as to their manners and customs. In the same way many important notes are given concerning the Chakhars, the Ordos, the Oluet or Ala-shan Mongols, the Tangutans, and the Dungans or Tungani. A large space is devoted to an account of the Mongol camel, in which some points are brought out that will be new to many; and the Argali (*Ovis argali*) and its habits are described in considerable detail, as also the White-breasted Argali of Northern Tibet (*Ovis poli*). Geographers will find some valuable information concerning the present course of the northern bend of the Hoang-ho, which is many miles south of that which is found on many modern maps. There seems to be now only one main channel, the two northern ones being dry. Many evidences are adduced to show that much of the region through which the expedition travelled was at one time an inland sea; most of the lakes are salt, and the country of Ala-shan seems to be one great desert of sand and clay mixed with salt. Col. Prejevalsky mentions an interesting fact showing how particular may grow into general terms. He tells us that the Mongols apply the term "Russian" to all Europeans, and affix "French" or "English" as they wish to designate either of these nations. They also believe the latter to be vassals and tributaries of the former, and Col. Prejevalsky mentions several circumstances tending to show the great opinion of Russian power held by the inhabitants of Central Asia. Lake Koko-nor and the region around it, as well as the province of Kan-su generally, in which the expedition spent many months, are described in all their aspects with the greatest minuteness.

But it is needless to attempt to give any adequate idea of the contents of these two volumes; they are a perfect mine of information about the whole of the little-known region visited by Col. Prejevalsky and his companions. The work is a fine example of what the narrative of a scientific exploring expedition should be, and although Col. Prejevalsky delivers "a plain unvarnished tale," his work is full of interest from beginning to end, even for the omnivorous "general reader." The map which accompanies the work is on a large scale and is filled in with such minuteness as to present a satisfactory bird's-eye view of the principal results of the expedition, and the illustrations are both attractive and useful. To quote the words of Col. Yule, "the journey and its acquisitions form a remarkable example of resolution and persistence amid long-continued toil, hardship, and difficulty of every kind, of which Russia may well be proud."

THE MOABITE QUESTION

Die Aechtheit der Moabitischen Alterthümer Geprüft. Von Prof. E. Kautzsch und Prof. A Socin. (Strassburg, 1876.)

Moabitisch oder Selimisch? Die Frage der Moabitischen Alterthumer neu untersucht. Von Adolf Koch. (Stuttgart, 1876.)

IT was perfectly natural that the discovery in 1868 of the famous Moabite Stone, which created such a sensation all over the civilised world, should have made literary and scientific men wish to explore the dangerous eastern side of the Dead Sea. Hence, when Dr. Ginsburg set forth the importance of an expedition to Moab in his paper before the Geographical Section of the British Association (Liverpool, 1870), the Association willingly granted 100*l.* towards the contemplated expedition, and in the following year supplemented this grant by another 100*l.* But this expedition which took place in the beginning of 1872, contributed next to nothing to our former knowledge of the trans-Jordanic regions. The only thing which it did effect was indirectly to encourage the designing Arabs in their production of Moabite antiquities.

Travellers in Syria well know the pertinacity with which they are pursued by the Arabs, who in every locality offer all sorts of relics for *Bakshish.* Hitherto these antiquities were principally confined to coins, chiefly of course shekels and half-shekels, bronzes, armoury, gems, wooden utensils, and pictures from the time of Christ, made by eye-witnesses of the scenes described in the Gospels. Since the discovery of the Sinaitic Codex and the Moabite Stone, however, which fetched so high a price, and which have created a perfect rage among a certain class of itinerant scholars for acquiring like precious relics, the finds have in a marvellous way corresponded to the desires of the inquiring travellers. A few months after the Tristram-Ginsburg expedition, in search for antiquities and specimens of natural history in Moab, was fitted out on such a pompous scale at Jerusalem, where the object of the journey became at once blazoned about, a number of inscribed stones were discovered, among which was one recording Psalm cxvii. As Herr Weser, the Chaplain to the German Consulate and Colony at Jerusalem, is the principal literary and scientific agent, who not only tested these Moabite antiquities on the spot, but also forwarded drawings of them to Germany and finally, with Prof. Schlottmann, induced the Prussian Government to purchase them and deposit them in the Berlin Museum, we cannot do better than give this learned Divine's own words :—"The fourth stone is to me the most interesting. It contains Psalm cxvii. in magnificent ancient Hebrew characters, similar to those on the stone of Mesha. Who knows but that this stone contains the very original from which the Psalm was read and adopted into the collection of Psalms." (*Die Aechtheit*, p. 13.)

As the famous Moabite stone records a biblical event, parallel to the one recorded in 2 Kings, iii., a discovery was at once made which should completely eclipse the narrative of this lapidary document, and at the same time vie with the celebrated Codex Sinaiticus. Prof. Scholz, who has been working for several years on the Massoretic text of Jeremiah in its relation to the Greek Septuagint, was in Jerusalem in 1870. Of course he visited Shapira's Antiquarian establishment, and naturally enough inquired after MSS. of the Hebrew Scriptures, when lo, and behold! this honest merchant showed the Professor, amongst other ancient Biblical documents, a remarkable manuscript of the very prophet on which Dr. Scholz was commenting. Here again we must give the words of the learned German, but this time no less a person than "Professor of Exegesis of the Old Testament and the Biblical Oriental Languages at the University of Wurzburg." In his work on Jeremiah which appeared at Regensburg, 1875, this learned Professor remarks :—"Perhaps it is not beyond all hope that science will come into possession of the text of Jeremiah which the Septuagint translated. In 1870 the author visited the bookseller Shapira at Jerusalem, who showed him a manuscript of Jeremiah, written very beautifully, without vowels and accents, which he averred corresponded to the translation of the Septuagint. When I called again, after a few days, it was sold to an Englishman. According to Herr Shapira, who declared that he possessed evidence for his statement, the MS. is of about the time of Christ."

But though *savans* like Pastor Weser and Prof. Scholz were easily deceived by the Psalm Stone and the Jeremiah MS., yet it was soon found that to continue discoveries in the department of Old Testament documents was both unprofitable and hazardous for very simple reasons. It is well known, even at Jerusalem, that no manuscript of any portion of the Hebrew Bible prior to A.D. 800 has as yet been discovered. If a MS. pretending to be of even 200–800 A D. were to be forthcoming, the science of palæography is now so definite and unerring that it would be detected at once. Nor could discoveries of any lapidary documents which exhibited a continuous narrative in any known Semitic dialect be safe, since the science of language is now so exact that an attempt to impose upon philology or palæography is almost certain to break down. Hence if the rage for inscriptions created by the discovery of the Moabite stone, and increased by the Tristram-Ginsburg Moabite expedition, which left England at the beginning of January, 1872, was at all to be gratified with any chance of safety and profit, nothing was left to the dealers in antiquities at Jerusalem but to open up new mines. This was easily done

Selim, who was in the service of the Duc de Luynes and M. de Saulcy, when these French *savans* travelled in Moab, and who had also been employed by M. Ganneau to negotiate with the Arabs at Dibon for the Moabite stone, was out of employment. Such an indication of Providence was too plain to be mistaken by good Shapira. Accordingly Mr. Shapira employed him at a monthly salary, to go to Moab in search of antiquities, and in addition to his fixed pay promised him a premium on every discovery. With such a temptation before him, this unmitigated rascal whom Drake describes as "a well-known scoundrel and forger," set out for Moab. No wonder that the search conducted by such a man and with such prospects, was eminently productive. In May, 1872, that is about a month or six weeks after the Tristram-Ginsburg expedition returned from Moab, a few specimens of pottery appeared at Mr. Shapira's depôt. In July the collection increased to 600 pieces, in October

to 700 pieces, and soon after it mounted up to 1,800 pieces. Shapira was now enabled to divide the finds into three collections, as follows :—

Collection 1. Containing 911 pieces, 465 inscribed ;
" 2. Containing 493 pieces, 60 inscribed ; and
" 3. Containing 410 pieces, 68 inscribed.

These collections embrace urns and pots, figures, idols, and birds partly entire and partly broken. Some of these antiquities have found their way to Stuttgart, but the bulk, consisting of the choicest specimens and numbering in all about 1,700 objects, have been bought from Shapira by the Prussian Government for 22,000 thalers = 3,300*l*., and are now deposited in the Berlin Museum. Prof. Koch, the author of the second treatise under review, who visited Shapira's depôt in 1875, tells us that this dealer has now another collection consisting of no less than 724 pieces, of which 133 are inscribed, containing in all 4604 letters (Dr. Koch, p. 3-22).

The interest of science in these discoveries is immense. If these antiquities could be proved to be genuine, their contribution to ethnology, history, mythology, philology, and palæography could hardly be overrated. They would exhibit to us the history of the mental and moral condition of a country, which has played an important part in ancient times, and about which we know next to nothing from the incidental and fragmentary allusions in the Old Testament. Literary and scientific opinion in England has almost unanimously declared these finds as forgeries. In Germany, however, where so many of the articles themselves are deposited, not a few men of eminent scientific attainments believe in their genuineness. Some of the results of these discoveries have even been embodied in no less a work than Riehm's "Dictionary of Biblical Antiquities," the distinguished editor of which professes to exclude everything that is controvertible, thus stamping this contribution as *veritable history*. The divided opinion in Germany may moreover be seen from the fact that of the two treatises which head this article, No. 1, by Professors Kautzsch and Socin, is against, whilst No. 2, by Prof. Koch is for the genuineness of these discoveries. After a careful study of the question, we shall endeavour to describe as briefly as possible the arguments adduced by Professors Kautzsch and Socin against the finds, with which we fully agree, unless those scholars who believe in the antiquities can produce more conclusive evidence.

1. The Duc de Luynes, M. de Saulcy, Palmer and Drake, Tristram and Ginsburg have more or less searched the country, and could find no traces of such articles, though the Moabites were perfectly alive to the value which Europeans set upon the most insignificant relic of any kind ; and though these Arabs, as we ourselves can testify, scraped together and offered for sale the most contemptible objects bearing the semblance of a relic.

2. In consequence of the large sum which was paid for the original Moabite stone, manufactories were opened in Jerusalem and elsewhere which produced inscribed stones, pottery, and other relics. That such forgeries were constantly forthcoming is admitted even by those who believe in the genuineness of the pottery in question. Indeed, Prof. Koch himself gives a detailed description of some of them (p. 67, &c.).

3. There can be no doubt that Selim was perfectly qualified to design these articles, both by his previous occupation as a Christian artist of sacred pictures, and by his subsequent training under the Duc de Luynes, M. de Saulcy, and M. Ganneau. That such an undertaking would be in perfect harmony with his well-known character as scamp and wholesale forger will likewise not be questioned.

4. The extraordinary rapidity with which these Moabite antiquities were supplied by Selim, when nothing of the kind could be found before, goes far to show that they were made under his direction. Only a few months before, we ourselves visited and searched some of the spots where Selim pretends to have made these discoveries, and could find no trace of such antiquities. The American exploration party have been there since (1873), and could likewise find nothing.

5. Drake and Ganneau traced the spot where these antiquities were made, and declared that they were manufactured in Jerusalem, transported to Moab, where they were buried, and then exhumed and sold to Shapira.

6. The intermixture of the earliest Phœnician with later forms of letters of which the inscriptions are made up, betrays the clumsy and unskilful manner in which they have been put together. That Selim and his companions knew these characters is perfectly certain. Not only did Selim copy for Ganneau some of the veritable Moabite inscription, but he and others possessed a facsimile of the inscription ; and we ourselves have seen in the hands of Mr. Shapira and other dealers in Jerusalem parts of the *Transactions* of the German Oriental Society, Levy's "Phœnizische Studien," with fac similes of various inscriptions, the fac-simile of the Eshmunazar Inscription, and the leaf from Madden's "History of Jewish Coins," which gives the different Semitic alphabets. These were carefully studied in Jerusalem.

7. But what confirms us in the belief that these inscriptions have been produced by individuals who simply knew the ancient alphabets but did not know how to compile a single sentence is the fact that, even under the immense pressure of Prof. Schlottman's great learning, the inscriptions have yielded no sense. So eminent an epigraphist, as the late Rödiger was forced to say, "that though these extensive Moabite texts are mostly written in characters, the value of which is perfectly fixed and certain, no connected sense can be discovered in them." ("Zeitschrift der Deutschen Morganlandischen Gesellschaft," xxvi. 817.) The force of this remark will be felt all the more when it is remembered that the language of the real Moabite stone can be understood by every Semitic scholar. Prof. Schlottman, who is too scientific an epigraphist not to see the strength of this argument is obliged to resort to the expedient that the inscriptions contain "strong abbreviations and permutations of letters."

The most extraordinary part of the controversy is the indecision about the clay of the pottery. We should have thought there could not have been two opinions among experts upon this question. If the authorities in the keramic art cannot definitely decide whether a pot or urn is three years or three thousand years old, there is little encouragement for those who have lately paid such enormous prices for old China. But whatever be the result of the controversy, the treatises of Professors

Kautzsch, Socin, and Koch which it has elicited will remain valuable contributions to palæography, and if it should call forth any more such solid disquisitions, science will be permanently benefited.

HOOKER'S "PRIMER OF BOTANY"

Science Primers. Edited by Professors Huxley, Roscoe, and Balfour Stewart.—"Botany." By Dr. J. D. Hooker, C.B., P.R.S. (London: Macmillan and Co., 1876.)

It is now almost universally admitted that the study of botany may be made an excellent training for children; but the extent of the subject is so great, and the phraseology has become so overwhelmed with technical terms that even those who have been the most anxious to see the science generally introduced into our schools as a branch of education, are much perplexed when called upon to determine in what way it can best be taught. Some think it most prudent to confine the attention of children to such points as may be observed with the unaided eye, or at any rate to such points as only require the help of an ordinary magnifying-glass; hence they limit the teaching of botany to a study of the more conspicuous parts of the higher groups of vegetable life, and leave the study of physiology and histology to a more advanced age. There is, no doubt, much that can be said in favour of this view, for in order to become fully acquainted with these branches of botany a much greater experience and skill in manipulation and experiment are required, as well as the use of high magnifying powers, than, it is quite certain, a child can be expected to possess. At the same time this limitation to so small a portion of botanical science has the tendency to produce in the mind contracted ideas respecting the true scope of the subject; for to a large extent it only admits of facts being heaped upon facts, without their proper connection one with another being made manifest. It is owing to this want of concatenation in the teaching that has led many to think less highly of botany as a branch of education than they otherwise might have done, and that its introduction into schools has not met with so much success as its more sanguine advocates could have wished to see.

The "Primer" of Botany by Dr. Hooker will go far to remove these difficulties, which have hitherto stood in the way of a more successful treatment of the subject; for in the simplest language, and with an absence of all technical terms but such as are absolutely necessary for a proper comprehension of the subject—and which, when they do occur, are always fully explained—the pupil is introduced to all the most important facts connected with structural and physiological botany. These facts, by means of a judicious arrangement and proper explanations, are made to exhibit their mutual dependence upon one another, and the work thus forms a continuous argument from beginning to end. Although the book contains only 112 pages, and is profusely illustrated, there is hardly a point in structure or physiology that is not touched upon, and so far as the scope of the book will allow, fully explained. A further very noticeable characteristic of the "Primer" is that the pupil is instructed to draw conclusions from information derived from observation founded upon experiment as well as from direct observation.

To teachers the "Primer" will be of inestimable value, and not only because of the simplicity of the language and the clearness with which the subject matter is treated, but also on account of its coming from the highest authority, and so furnishing positive information as to the most suitable methods of teaching the science of botany, and for the want of which the instruction given in schools has hitherto been too often of a most capricious description. Again, those who have the formation or management of gardens, set aside for botanical purposes, entrusted to them, will find the list of plants at the end of the book extremely useful, as it contains those which experience has shown to afford the best examples of the particular characters it is desirable to illustrate; they are also such as may be readily procured and easily grown.

If the "Primer" has long been looked for, the high expectations which have been raised are not doomed to be disappointed, and it may be confidently anticipated that its introduction into schools will determine very largely the direction which the teaching of botany in this country will take for the future.

M. A. Lawson

OUR BOOK SHELF

Aventures Aériennes et Expériences Memorables des Grands Aéronautes. Par W. de Fonvielle. Ouvrage orné de 40 gravures. (Paris: E. Plon, 1876.)

M. de Fonvielle's name is no doubt familiar to our readers as that of an experienced scientific aeronaut and writer on aeronautics. In the work before us he has traced in an interesting and instructive manner the history of ballooning from the first rude attempts to rise in the air, down to the elaborate experiments and machines which have been devised at the present day. He has evidently spent considerable pains to obtain a complete knowledge of the history and methods of ballooning, and his scientific knowledge enables him to point out in the many experiments which have been made, the causes of failure or success. The work is evidently meant mainly for popular reading, and those who understand French will find it full of interest. The author attempts to show how practically to utilise a discovery which up to the present time has produced few practical results. He is quite opposed to all the fantastical projects which have been proposed and tried in aeronautics, and treats his subject, on the whole, in a sensible and moderate fashion, showing that those chimerical schemes have been really hindrances to the improvement of aërial navigation. He shows that important meteorological results might be obtained by properly organised ascents, and that indeed in this respect results of some importance have already been obtained. The numerous illustrations are interesting, and altogether the work may be regarded as an important contribution to the history of aeronautics.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

New Laurentian Fossil

Mr. James Thomson, of Glasgow, who has been for some years on the out-look for fossils in the Laurentian rocks of Scotland, and has searched parts of Argyleshire, Inverness-shire, Ross-shire, and Caithness with this object, has lately been rewarded by the discovery, in the neighbourhood of Tarbert,

Harris, of what is regarded by every Palæontologist who has seen the specimen as an unquestionable *organism*. It forms part of a limestone bed intercalated with dark grey shale, and occurs in the midst of highly metamorphic rocks (among them a graphite granite), which were regarded by Sir Roderick Murchison as of Laurentian age, and which have ever since passed as such—no doubt being entertained as to their antiquity by Dr. Heddle, of St. Andrew's, who has geologised over the whole of Harris.

Judging from the sections which Mr. Thomson has forwarded to me, the fabric seems to have consisted of superposed layers of calcareous shell-substance, whose continuity is frequently interrupted; the spaces between these layers, which are much thinner than the lamellæ themselves, being irregularly and imperfectly divided (very much as in Eozoon) into separate chambers, which are filled up with calcite. The state of preservation of the fossil thus corresponds exactly with that of the Silurian *Stromatopora*, to which, indeed, it bears a strong general resemblance, except in the larger proportion borne by the solid fabric to the chambers it encloses. The shelly layers are as distinct in character from the calcite contents of the chambers, as are those of the Nummulites of the pyramid-limestone, with which they agree in their remarkable hardness, corresponding with that of porcellanous shell. Altogether I have no hesitation in concurring with Prof. H. A. Nicholson, Prof. Geikie, and Mr. Etheridge in affirming it to be so unmistakeably organic, that, if it be claimed by mineralogists as a "rock-structure," a large number of universally-accepted fossils will have to go along with it. As it is *essentially calcareous* in its composition, there is no room for the hypothesis of its production by the process of "mineral segregation," which is maintained by certain Mineralogists (others of at least equal eminence, however, entirely dissenting from them) to have been adequate to the production of the alternating layers of serpentine and calcareous shell-substance in the Canadian *Eozoon*. And though mineralogical analysis might not improbably detect small particles of various minerals in its substance, their presence no more establishes its claim to be regarded as a mere rock-structure, than does the presence of siliceous films (probably replacing the soft parts of the animal) in a piece of coral-limestone.

Not having made any other than a general examination of the structure of the Harris specimen, I do not feel able to give a positive opinion upon its affinities; and it may be that these may long remain doubtful. But this doubt no more constitutes an adequate reason for refusing to accept its organic origin, than it does in the case of *Stromatopora*; which no Mineralogist that I ever heard of claims as a mineral, though the Zoologist cannot say with certainty whether it is a foraminifer, a sponge, a coral, or a polyzoary. It is to be borne in mind that in very few Palæozoic fossils is there a *precise* conformity to any existing type; and such conformity is, of course, still less to be expected in a Laurentian than in a Silurian fossil.

It is not a little singular that I should have received about the same time from Prof. Mobius of Kiel, specimens of a new Foraminiferal organism, discovered by him in 1874 on a coral reef off Mauritius; which presents more resemblance in its spreading and encrusting mode of growth to the indefinite expansions of *Eozoon* and *Stromatopora*, than does any Foraminiferal type previously known. Truly, as I have before had occasion to say, "there is no limit to the possibilities of Foraminifera."

I have only to add, in regard to the Harris fossil, that the further prosecution of the inquiry into its structure and relations has been placed by Mr. Thomson in the able hands of Prof. H. Alleyne Nicholson, and that it is at the joint request of these two gentlemen that I make the present communication.

WILLIAM B. CARPENTER

The Warm Rain Band in the Daylight Spectrum

ON taking my accustomed spectroscopic peep at the sky today, through a little garret window in the Royal Observatory here, I was instantly struck with the presence of the same dark band in the spectrum to which I called your attention last summer twice over (vol. xii. pp. 231, 251).

The band was very faint, but it was there, and this was its first appearance, to me at least, during the present year. I have not indeed been so persevering in that sort of observation as I perhaps should have been if furnished with better instruments, yet for weeks and weeks past I *have* scanned the sky, not only when it was heavily clouded, but also when rain was actually falling with west, south-west, and north-east winds, and sometimes during dense, wet fogs, when very little daylight at all was left, and under some preternaturally low barometric pressures. Yet, under all these circumstances, I put the spectroscope back into its box after each trial with the assurance that no rain-band had then been shown by it. This morning, however, and under a barometer not low, viz., 29·8 British inches, the band exhibited itself instantly; and on my going out to look at the direction of the wind, behold it was from the south-east. Wherefore I had no scruple in informing a professor whom I met in the afternoon at the College, and who, after his day's work there was going home to indulge in the amenities of horticulture, that his flowers were certain of presently having the luxury of *warm rain*.

Such rain, too, did begin, within an hour of that interview, with large heavy drops, and the evening has ended with almost a soaking rain.

It is rather too soon to attempt fully to describe the spectrum appearance, much less to explain it, before I have had the privilege of using anything in the way of a notable spectroscope upon it. But having been already written to for some practical information, even from St. Petersburg (where NATURE is evidently read with attention), I may remark that the nebulous band character of the phenomenon is simply a result of want of light; for when the quality to give the band was present in the air, and the sun has been prevailed on to shine for a moment through that air, and into the spectroscope, the band was instantly resolved into a group, or groups, of fine and sharp black lines, exquisitely visible.

But as the sun is seldom to be seen in any weather threatening rain, whether warm or cold, in fact, cannot be consulted precisely at those times when he is most wanted, it is better to restrict such pluvio-spectroscopy to ordinary sky, *i.e.*, clouds or air; and if possible in a polar direction, so as to be equally distant from the sun, whether visible or not, all the day through; and not too low, in altitude, lest smoke, local moisture, and other impurities have too great and variable an influence. The Observatory garret-window here, I regret to say, is not so unexceptionably situated in azimuth as it might be, for it looks out straight to the south, and the angle at which I usually look through it, on being measured to-day, turned out to be 23°.

Nevertheless, at that altitude, keeping to it steadily on all occasions, and in that direction, avoiding always the garish spectra of actual sunshine, and depending not on any particular and absolute spectrum representation in the published maps of other observers, but chiefly or entirely attending to the *differences* observed by myself from day to day in my own manner with my own little tube, there was no difficulty in instantly pronouncing this morning that there was something in the air through which daylight was then passing different from what it has been for several months past.

Whether that something is only watery vapour at a high temperature (seeing that watery vapour at a low temperature does not produce it), or whether the air is carrying something else with it, giving to the south-east winds here a slight approach to the quality of the siroccos of the Mediterranean, which are often transfused with fine dust along with their warm rain, and do produce some very noteworthy markings in the spectrum, is a matter for further and wider research by those who are instrumentally and financially better able to follow it up; and who should therefore be implored in the present state and needs of science to perform their part without further delay.

PIAZZI SMYTH,

Edinburgh, April 24 Astronomer-Royal for Scotland

Limestone Makers

MR. J. MUNRO'S interesting letter and sketch which appeared in NATURE, vol. xiii. p. 510, show how much may be done in the Tropics by ordinary observers towards elucidating many geological problems. His sketch is that of one of the genus Corallina, a member of the Florideæ, and it is a very common lime maker at the Bermudas. Although Mr. Munro will not find a list of the different limestone makers in books, still in the vast unwritten knowledge of geology it is well known that shells, foraminifera, serpulæ in numbers, and huge masses of Nullipores, besides the corallines, contribute to the coral stock.

The corallines present many and varied forms on our own coasts, but their beauty and construction are remarkable in the warm waters of the Gulf Stream and Caribbean Sea. Through the kindness of Mr. Henry Lee I have lately had the opportunity of examining the newly-started growth of the common *Corallines officinalis*, but curious as its cellular development is, it is

a dwarf in comparison with those seen by Mr. Munro and Mr. Quin. Doubtless the broken-down and pulverised corallines fill up many a crack in the reef's limestone. Should Mr. Munro be desirous of seeing some of his old West Indian corallines, I shall be glad to show him some microscopical results of work upon them. P. MARTIN DUNCAN

Geological Society, May 1

History of Magnetism

A PARAGRAPH in the article on "The Early History of Magnetism," in your last number, contains a passage which requires, I think, a note of explanation. The writer says: "A Latin letter ascribed to Peter Adsiger, 1269, preserved among the manuscripts of the University of Leyden, contains the following remark on the declination of the needle . . ." Now Humboldt, on the authority of Libri, denies the existence of the passage in the Leyden MSS., affirming that it is only an interpolation in a Paris copy. But what is of more importance, he also states that the title of the letter is "Epistola Pêtri P. de Maricourt *ad Sigernum* de Foucoucourt." E. Walker, in his well-known essay on Magnetism, refers to Cavallo as quoting the supposed letter of Adsiger. S. J. PERRY

Meteorological Society

WHILE thanking you for your friendly notice of the Annual Report of this Society, I trust you will allow me to state that we have not made "the mistake in science regarding the height of the thermometers above the ground," as very naturally imagined by you from the matter not having been mentioned. The fact is, we have been unusually strict on that point; our thermometers are all 4 feet (within, perhaps, 2 in. + or --), and as the uniformity was so strict, it was considered useless to repeat the statement for each station, and so, finally, it escaped mention altogether in the printed abstract. Of course the question (Report, p. 52), "What is the height of the bulbs above grass?" is duly answered on the MS. inspection forms deposited in the library of the Society.

May I, in conclusion, express the hope that the example which we have set by publishing the lithograph ground-plans, and which you so highly approve, may be generally followed both in this country and abroad? G. J. SYMONS

Meteorological Society, 30, Great George Street,
Westminster, S.W., April 28

Destruction of Flowers by Birds

THE enclosed blossoms of the common "wild" cherry (*Prunus avium*, L.) have been mutilated in a precisely similar manner with those of the blackthorn noticed about a year ago in NATURE (vol. xii. p. 26), the petals and stamens still adhering to the separated limb of the calyx, which has been cut through at the exact level of the ovary, which has perhaps been the object of attack. Orchard trees in the neighbourhood from the same stock have also suffered to a serious extent, but the wall-cherries (*P. cerasus*, L.), which are later in flowering, have hitherto been untouched. R. A. PRYOR

Hatfield, May 2

OUR ASTRONOMICAL COLUMN

THE NEBULA IN ORION.—M. Tisserand, Director of the Observatory at Toulouse, commenced on Feb. 17 of the present year, a close examination of the small stars in the vicinity of the trapezium in the great nebula of Orion, with the Foucault telescope of $0^{m}\cdot80$ aperture, which had been completely mounted at the beginning of the same month. To facilitate the study of this region, which it is intended shall form part of the work with this fine instrument, a chart was prepared on a large scale containing the 155 stars, the positions of which relatively to θ^1 Orionis, were determined by M. O. Struve (*Observations de la Grande Nebuleuse d'Orion* in the St. Petersburg Memoirs, vol. v.); of these 155 stars it may be mentioned that 150 occur in Sir John Herschel's list in the volume of observations made at the Cape of Good Hope. Especial attention was directed at Toulouse during the few weeks that the nebula could be observed in the last season, to the stars which M. O. Struve had indicated as variable. The star II ($\Delta\alpha$ . . $-7''\cdot3$, $\Delta\delta$ . . $-27''\cdot6$) which is not in Herschel's catalogue, was noted on Feb. 17 and 21 at the extreme limit of visibility: on following days, when the sky was more transparent, it could not be discerned; at maximum according to Struve this star is of the twelfth magnitude, the smallest star which can be distinctly seen in the Pulkowa refractor being considered 13·5—a very different scale of magnitude, it will be remarked, from that of Bessel; No. 78 ($\Delta\alpha$ . . . $+34''\cdot5$, $\Delta\delta$ . . . $+9''\cdot7$), varying, according to Struve, from 12·5 to invisibility, was not discerned; No. 75 ($\Delta\alpha$ . . . $+21''\cdot3$, $\Delta\delta$ . . . $+39''\cdot2$) was 14-15 on March 14; Tisserand found No. V. of the Pulkowa list ($\Delta\alpha$ . . . $+378''\cdot3$, $\Delta\delta$ . . . $+66''\cdot3$) extremely faint on Feb. 24, and quite invisible subsequently, whence he concludes this star to be also variable, and that its non-insertion by Herschel may have arisen from its being at a minimum at the epoch of his observations.

Thirty-two stars have been remarked at Toulouse, which are not in the Pulkowa catalogue; of these fifteen occur in Bond's catalogue, in vol. v. of "Annals of the Harvard Observatory"; the remaining seventeen which have not, as it appears, been previously observed, are generally very faint, the only notable exceptions being in the cases of two stars, which have the following estimated co-ordinates relative to θ^1.

$\Delta\alpha$	$+180''$	.. $\Delta\delta$	$-180''$
,, . ..	$110''$	. ,, ...	$480''$

The first star was 13 (an object termed *très belle* with the Toulouse instrument) on February 17, but had become extremely faint on March 14 and 26. The second star is estimated 13, almost as bright as its neighbour, No. 55 of Struve's catalogue. M. Tisserand states that he has not been able to recognise all the stars in Bond's catalogue, more particularly in the neighbourhood of the trapezium.

The numerous variable stars, which we have now reason to suppose exist in the nebula of Orion, certainly form one of the most significant and interesting features in the history of that grand object.

It may be added here that M. Tisserand has also employed the powerful optical means now at his command, upon observations of the satellites of Uranus.

NEW MINOR PLANETS.—Still another small planet is announced during the last week. It was found by M. Perrotin at Toulouse on April 26, in R.A. 14h. 11m. 48s, N.P.D. 96° 24′; twelfth magnitude.

The planet detected by Prof. Watson at Ann Arbor on April 19 is called No. 161 in the *Astronomische Nachrichten*. These numbers, however, are now in much confusion, and names for those which are observed a sufficient length of time to allow of the determination of elements have an obvious advantage over the system of leaving these planets to be distinguished by a number only. As regards numbers there is even doubt as far back as No. 149, which has not yet been shown to be distinct from Frigga (No. 77).

BIELA'S COMET AND THE NOVEMBER METEOR-STREAM.—If we take for the orbit of the November meteor-stream the elements calculated by Prof. J. C. Adams, and communicated to the Royal Astronomical Society in April, 1867, and for Biela's comet a mean of the sets of elements for the two nuclei in 1866, given by Clausen in "Melanges Mathématiques et Astronomiques," &c., t. iii., of the Imperial Academy of St. Petersburg, we find for the least distance between the tracks of the comet and the meteors, 0·054, the mean distance of the earth from the sun being taken as unity. This nearest point of approach is in heliocentric longitude 61° 30′ (equinox of 1866), where we have—

	Comet	Meteors.
Heliocentric latitude . .	0° 58′ N.	2° 57′ N.
True anomaly...	311° 44′	356° 24′
Radius-vector.	1·0266	0·9865

The approximation of the orbit of Biela's comet to that of the November meteor-stream, and consequently to that of Tempel's comet, 1866 (I.), was first pointed out by Prof. Bruhns, of Leipsic, in *Astron. Nach.*, No. 1681, but the heliocentrics there employed were deduced from the geocentric places of Santini's rough ephemeris.

PROF. FLOWER'S HUNTERIAN LECTURES ON THE RELATION OF EXTINCT TO EXISTING MAMMALIA[1]

IX.

THE disputed zoological position of the Lemurs, and the great importance which has been attached to them by some zoologists, who regard them as the direct transition between the lower and higher mammals, and as survivors of a large group now almost extinct, through which the higher Primates must have passed in the progress of their development, give great interest to the consideration of their ancient history.

Until very recently fossil Lemurs were quite unknown, at all events the affinities of certain remains provisionally assigned to the group were much questioned, but within the last few years the existence of Lemuroid animals in Europe during the early Tertiary period has been perfectly established, and remains of a large number of animals attributed, though with less certainty, to the order, have been found in beds of corresponding age in North America.

In 1872, a nearly complete skull of an animal somewhat allied to the modern African Pottos and Galagos, though of a more generalised character both of cranial conformation and dentition, was described by M. Delfortrie, under the name of *Palæolemur betillei*. It was found in phosphatic deposits, probably of early Miocene age, in the department of Lot. It was soon afterwards discovered that certain more or less fragmentary specimens which had been long before described, and had been generally though doubtfully referred to the *Ungulata*, were really nothing more than animals of the same group, and probably even of the same species. These are *Adapis parisiensis*, Cuvier, from the Paris gypsums, *Aphelotherium duvernoyi*, Gervais, and *Cænopithecus lemuroides*, Rutimeyer. The recognition of these animals as Lemuroids shows how little reliance can be placed upon the characters of the molar teeth alone in judging of affinities, and should also lead to the re-examination of some of the smaller mammals of our own Tertiaries, such as *Microlophus*, as it is not improbable that Lemurs may be found among them. The same deposits in which M. Delfortrie's specimen was found, have since yielded two other skulls, one of smaller and the other of larger size, named by M. Filhol, *Necrolemur antiquus* and *Adapis magnus* respectively. It should, however, be mentioned that M. Filhol only admits the first to be a true Lemur, and considers the genus *Adapis* as the type of a hitherto unknown group of mammals, intermediate between the Lemurs and Pachyderms, to which he gives the name of *Pachylemur*.

Of the supposed low and generalised forms of Primates from the Tertiaries of North America, the existence of which was announced almost simultaneously by Professors Marsh and Cope in 1872, it is difficult to speak with certainty at present, as the descriptions which have reached this country are not very detailed. As many as fifteen genera have already been named. They are nearly all from the Eocene formations, two only having been found in the lower Miocene.

The remains of no true monkeys have hitherto been discovered in the Eocene, but several species have been found both in Miocene and Pliocene formations in Europe. The most abundant and best preserved are those from Greece, *Mesopithecus pentelici*, allied to the existing genus *Semnopithecus*, though with shorter and stouter limbs. Others have been found in the Siwalik Hills of India allied to the same form, and in France, the South of Germany, and Italy, related to the Macaques and to the Gibbons. The most interesting species is one known by the lower jaw only, from a Miocene bed at St. Gaudens, in France, described by Lartet under the name of *Dryopithecus fontani*. Its affinities have given rise to some discussion, but as far as can be decided from the evidence before us, it appears intermediate between the chimpanzee and gorilla, and of the size of the former. Considering how nearly the Miocene fauna of Europe resembles in its general features the actual fauna of Africa, it is not surprising that an ape of the genus *Troglodytes* should have formed part of it. No remains of monkeys allied to the existing American forms have been found in the Old World, and conversely, all those discovered by Lund in the Brazilian caverns belong to the families now inhabiting the same part of the world. No monkeys have yet been found in the alluvial deposits of the plains, which are so rich in the great Edentates, nor in fact have they been met with in any older South American Tertiaries. The ancient history of the group, as revealed to us by palæontology, is therefore extremely incomplete. Further researches into the fauna of the North American Eocenes may throw some light upon it.

No actual remains of man have been met with which can be said with certainty to be older than the Pleistocene period, though it is asserted that his existence upon the earth in the Pliocene and even Miocene epoch is proved by works of art found in deposits of those ages. These, however, are questions to be decided by the antiquary and the geologist, and are beyond the scope of the anatomist. The oldest known remains of man from European caves (with perhaps the exception of the celebrated skeleton from the Neanderthal, the age of which is doubtful) do not differ more from modern Europeans than do several of the lowest modern races. In other words, no proof of the existence in former times of a race of men inferior in general organisation to the Australians, and forming any nearer approach to the lower animals, has yet been discovered.

In reviewing our present knowledge of the palæontology of the Mammalia we see immense progress of late years, giving hopes for the future. Here and there we have tolerably complete histories of gradual modification of forms with advancing time, and adapted to the exigencies of changing circumstances, as among the Ungulata and the Carnivora; and we have many instances of extinct forms filling the gaps between those now existing. But still there are great gaps or rather gulfs between most of the large groups or orders, without at present any trace of connecting links, or anything to indicate how they were once filled up, as must have been the case if they have all been gradually evolved from a common origin. We have very much to learn before we can speak with any confidence upon the manner in which all the diversities of form we see around us have been brought about, or attempt to construct pedigrees or phylogenies, except in the most provisional and tentative manner.

[1] Abstract of a course of lectures delivered at the Royal College of Surgeons "On the Relation of Extinct to Existing Mammalia, with Special Reference to the Derivative Hypothesis," in conclusion of the course of 1873. (See Report in NATURE for that year.) Continued from vol. xiii. p. 514.

INTERNATIONAL METEOROLOGY

THE Permanent Committee of the Vienna Meteorological Congress has just held its third meeting in London, which lasted from the 18th to the 22nd April inclusive. The members present were Prof. Buys Ballot (Holland), president, Professors Bruhns (Germany), Cantoni (Italy), Mohn (Norway), Wild (Russia), and Mr. Scott. Prof. Jelinek (Austria) was unfortunately absent owing to ill-health.

Among numerous subjects which came up for consideration, it appeared that the scheme for publication, in a uniform manner, of actual observations and monthly results from a limited number of stations in each country, which are to be considered as international, had been already accepted almost without exception or suggestion of amendment by all the countries which had been present at Vienna. It is hoped that this measure will ultimately tend to bring about uniformity in hours and methods of observation.

In weather telegraphy it was resolved to calculate gradients in the metric scale, as millimetres per one degree (sixty nautical miles). In this country they will be referred to English units. It was not found practicable to endeavour to introduce uniform hours for observations in weather telegraphy in Europe at present. As to weather charts, a proposal for the exclusion of all meridians except that of Greenwich was postponed to the next Congress. It was resolved to take advantage of that meeting to attempt to effect the comparison of the principal standard barometers by means of travelling barometers to be conveyed to the place of meeting, and left there for a considerable time.

It was recognised as impracticable at present to create an International Meteorological Institute, and consequently it was decided that international investigations must be carried on at the expense of individual nations, other nations to be requested to furnish materials, as far as possible, in a usable form. A list of upwards of 200 subscribers to the international synoptic weather charts of Capt. Hoffmeyer was announced.

Resolutions were adopted in favour of the establishment of stations on high mountains, and in distant localities, and Lieut. Weyprecht's proposition for a circle of observing stations in the Arctic Regions round the Pole was recognised as scientifically of high importance and deserving of general support.

With reference to universal instructions for observations it was stated that no general form of instructions could be drawn up to suit all climates, and it appeared to the committee that the instructions recently prepared in the German, Russian, and English languages respectively, as well as in Italian (as soon as some contemplated modifications shall have been introduced), were sufficiently in accordance with the requirements of the Vienna Congress. It was hoped that ere long French instructions of the same tenor would be issued.

It was announced that the Italian Government was prepared to invite the next Congress to meet at Rome in September 1877, and the proposal was most gratefully accepted. In preparation for this meeting a number of reports on the present state of the different departments of the science are called for from various meteorologists. The questions to be treated in these reports are mainly instrumental, and they are of great importance in the present state of the subject. The detailed Report of the Committee will be published without delay.

SOIRÉE OF THE ROYAL MICROSCOPICAL SOCIETY

ON Friday, April 21st, Mr. H. C. Sorby, president of the Royal Microscopical Society, gave a large *soirée* in the apartments of King's College. Invitations had been issued for above 1,500, including the whole of the Fellows of the Royal Microscopical Society, the presidents and leading officers of many of the London Scientific Societies; all the distinguished foreigners now in London as commissioners from the various foreign Governments to the Exhibition of Scientific Apparatus at South Kensington; and many of the President's private friends. About 800 were present, including about 300 ladies. After having been received by the President and one of the secretaries, the visitors passed into the various rooms of the College, in which were exhibited many objects connected with microscopical science. For the number, variety, scientific value, or general interest of the specimens, this exhibition has probably never been surpassed. Amongst the new instruments may be mentioned Mr. Sorby's arrangement for accurately measuring the wave-length of the centre of absorption-bands in spectra; a new form of Stephenson's erecting binocular microscope, by Mr. Bevington, and another by Mr. Browning, of somewhat different construction. Mr. Browning also exhibited his new portable microscope, which is so constructed that the body can be turned on one side and reversed in such a manner as to reduce the height to about one half. The President also exhibited a large series of specimens illustrating his own special subjects, shown by means of fifty microscopes, lent to him by four of the principal makers in London (Becks, Browning, Crouch, and Ross), and about 150 first-rate instruments and objects were contributed by the Fellows of the society and other friends. These were so distributed over the large apartments of the College as to avoid crowding in any part. Almost every branch of science to which the microscope has been applied was well represented, and many of the finest specimens ever prepared were shown and described. Many very interesting living objects were sent direct from the Brighton Aquarium and elsewhere. In the lecture theatre were exhibited Dr. Hudson's most beautiful drawings of microscopic objects shown in a new manner as transparencies; Mr. Spottiswoode's splendid polarising apparatus, and various objects shown with the oxy-hydrogen microscope by How and Company. The large entrance hall was decorated with plants and flowers, and used as a promenade. The two museums of the College were also thrown open. Refreshments were supplied by the steward of the College. The guests were provided with a classified catalogue of the objects exhibited, but they were so numerous that it was impossible for any one to examine more than a small part of the whole. One of the most satisfactory results of the *soirée* is the great impression produced by it on the foreign scientific men, who appear to have been quite unprepared for, and greatly surprised at, what they saw during the evening.

ON CERTAIN METHODS OF CHEMICAL RESEARCH [1]

THE lecturer began by describing the simple form of apparatus which he employed many years ago in his researches on the heat evolved in the combination of oxygen, chlorine, bromine, &c., with other bodies. In every case the bodies to be combined were inclosed in a vessel surrounded with water, and the combination was effected either by the ignition of a fine platinum wire, or where they acted directly upon one another, by the fracture of a glass capsule containing one of the combining bodies, the heat being measured by the rise of temperature of the water. He next referred to the arrangement by which he had been the first to decompose water so as to render visible the hydrogen and oxygen, and to measure their relative volumes by means of atmospheric electricity and of electrical currents from the ordinary machine. For this purpose fine platinum wires were hermetically sealed into fine thermometer tubes, which were then filled with dilute sulphuric acid by withdrawing the air by ebullition. The same current of frictional electricity will decompose the water in almost an indefinite number such couples arranged in a consecutive series. Capillary tubes of this kind may be employed for eudiometric experiments, which would be exceedingly tedious in wide tubes. Thus oxygen gas can at once be absorbed by passing the silent discharge through it while standing

1 Abstract of a Lecture to the Chemical Society by Dr. Andrews, F.R.S., April 28. Communicated by the author.

over a solution of iodide of potassium By means of the air pump it is easy with a gentle exhaustion to expand the gas so that it may fill the whole tube while the open end is immersed in the liquid which it is desired to introduce, on removing the pressure the gas will be in contact with the new liquid

The lecturer exhibited some of the original tubes with which Prof Tait and he first determined that ozone is a condensed form of oxygen, and explained a form of apparatus by means of which this important fact can be exhibited as a class experiment A full description of this apparatus will be found in his lecture on ozone, which was delivered some time ago before the Royal Society of Edinburgh, and has since been published by the Scottish Meteorological Society With this apparatus the lecturer has been able to determine that chlorine gas undergoes no change of volume from the prolonged action of the electrical discharge His experiments on this subject have not yet been published, but they were made under singularly favourable conditions for discovering a very small change of volume in the gas if any such change had occurred

The lecturer in the next place briefly alluded to the method he formerly employed for determining the latent heat of vapours of which a detailed account was given in a former communication to the Chemical Society The apparatus employed admits of exact experiments being made on a small scale, and consequently on substances in an absolutely pure state, an object of even greater importance in inquiries of this kind than in ordinary chemical analyses He remarked that a large field for investigation in this part of the domain of science lay comparatively uncultivated and would yield a rich harvest of results to anyone who would enter upon it

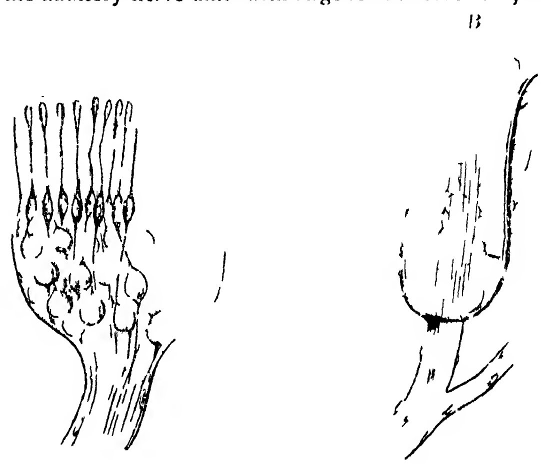
Passing from this subject the lecturer described a dividing and calibrating machine which he contrived some years ago for the special work in which he has been engaged, and which has given to many of his investigations an accuracy otherwise hardly attainable He has been enabled by means of it to construct thermometers whose readings are absolutely coincident throughout every part of the scale and to calibrate with almost perfect accuracy the glass tubes used in his pressure experiments It would be impossible in an abstract to describe the construction of this machine but it may be important to mention that the screw which moves the microscope or divider is a short one of remarkable accuracy constructed by Troughton and Simms

The last subject treated was the lecturer's method of investigating the properties of gaseous and liquid bodies at high pressures and under varied temperatures By means of his apparatus, which was exhibited to the meeting pressures of 500 atmospheres can be readily observed and measured in glass tubes in a word, a complete mastery obtained over matter under conditions hitherto beyond the reach of direct observations This has been effected by a novel mode of *packing* a fine steel screw, so that while entering a confined portion of water no leakage whatever occurs under enormous pressures, and also by a peculiar method of forming a tight junction between glass and metal The lecture was concluded by a short statement of the more important results lately communicated to the Royal Society on the properties of matter in the gaseous state

SCIENCE IN GERMANY

(From a German Correspondent)

IN my last communication (NATURE, vol xiii p 75), I noticed the researches of Ranke on various organs of sense of the lower animals A new series of these researches having since appeared, I will give some account of them in what follows Ranke (*Zeitschrift fur Wissenschaftliche Zoologie*, xxv, 2 Heft Supplement) has studied more closely, in their physiological relations the organ of hearing of certain grasshoppers (*Acridii*) and snails (*Pterotrachea*) and the eye of the leech, which organs were previously known in general from the researches of Siebold, Leuckart, Leydig, Boll, and others The Acridii carry their organ of hearing on the base of the hind most extremity It consists essentially of a membrane, which is stretched within the body wall on a fixed ring, and an auditory nerve, which is connected from within to that membrane, and ends on it in a swelling or so called ganglion That membrane is undoubtedly to be compared with the membrane of the tympanum in the ear of the most highly organised animals, inasmuch as, like this, it is put in vibrations corresponding to the sound waves in the air and transfers these vibrations to the parts lying within In the higher animals, these parts consist of rigid lever arrangements (small bones of the ear), which, however, are connected with the acoustic nerve not directly, but through a transmitting apparatus, which separates the vibrations produced by various sound waves and specially prepares them for conveyance by the nerve In the Acridii the whole internal conduction of the sound wave is more simply arranged, the ganglion on the tympanic membrane consists of two different halves in the interior the finest nerve threads proceeding from the auditory nerve unite with large round nerve cells, from



[illegible]

which they proceed to the boundary of the half of the ganglion and there end in smaller nerve cells The outer half of the ganglion consists of a brighter and delicate ground mass, in which very fine rods, transparent like glass, and fixed, run parallel towards the tympanic membrane they spring out of those smaller cells terminate on the tympanic membrane with longish thin ends and may be regarded as the end apparatus of the nerve conduction But while thus the vibrations of the tympanic membrane are communicated to the rods and from them direct, without further intervention, to the nerve apparatus there is not entirely wanting a weakening or damping arrangement for the sound wave for the ground mass, in which the rods rest may very well be regarded as such an arrangement As the rods are all formed alike, the sensations of tone by the Acridii must be always homogeneous and simple, and if we may suppose that the organ of hearing of these animals is adapted to their own production of tone, by which they excite sexual desire, then their monotonous rattle agrees with the arrangement of the auditory apparatus for a simple sensation In other grasshoppers, the Locustidæ, the vocal organ produces a sound compounded of more tones, and correspondingly, they have on their fore legs an organ of hearing, the rods in which are of various length and breadth, and, arranged like the wires in a

piano, evidently serve for excitation of different sensations of tone. The organ of hearing of the Acridia is then, simple, in a similar sense to that of the simple eyes which perceive light but not colours and forms, and therefore it closely approximates to the organs of touch, which likewise render sensible simple mechanical stimuli, and are often arranged in a way similar to those organs of hearing.

The eye of the leech consists of a cup-like inflexion of the skin, which is so lined with large transparent cells that only a narrow axial canal remains. The nerve stem which enters at the bottom of the cup, fills this canal up to a certain height and ends there with a ganglion, while the nerve fibres pass into small cells, whose outer end runs out into a short rod; the entire cup is coated round with a pigment skin and enveloped in muscles which are directed partly parallel, partly at right angles to the skin surface, and therefore can draw the whole cup with its sheath inwards or press the contents somewhat outwards. The former happens when the animal is surprised by sudden light, just as we close our eyes in like circumstances. After some time, the leech opens its eyes, a part of the glass-like cells on the rim of the open cup being pressed out in form of a compact hemisphere. In this way a pretty perfect visual apparatus is arranged. The outer glass-like hemisphere corresponds to the light-refracting medium of a more perfect eye. The mosaic of rod cells behind receives the separate rays and conveys the stimulus to the nerves, while the pigment layer cuts off all round the light that has penetrated. Besides these eyes on the upper lip the leech possesses on other parts of the body organs constructed quite similarly, only without a pigment skin, so that they cannot be visual organs. On the other hand they are thrust out when the animal is feeling about, and are thus evidently organs of touch; but at the same time the organs of sight are used in the same way, and when the animal sucks in the liquids agreeable to it it draws the upper lip with the open organs of sight into the mouth. It would appear, then, that these organs are at once the means of sensations of touch, taste, and sight. To conceive this rightly we must consider that in the lowest animals the special sensations of sense are not yet differentiated; their body is in all parts alike sensitive, and sensation can only mean, quite generally, ease or uneasiness. In a higher form of organisation, certain body parts are by peculiar arrangement, rendered sensitive to pressure, heat, light, and chemical stimulation. But before such a simple organ of sense develops in one direction for a particular kind of stimulus, it can also communicate simple sensations of a different kind. We ourselves know such a combination of different sensations through the same organ of sense; we [illegible] at the boundary of the tone-conductors, may feel, instead of tones, simply a vibration or a tickling, and thus has a sensation of touch like that produced in a finger-point when a vibrating tuning-fork is applied to it. Again, in our tongue, sensations of taste, smell, and touch are mixed together. Thus the organ of hearing of Acridia, which can only feel hissing noises, but no tones, may be compared, in the quality of its sensation to an organ of touch; and of the visual organ of the leech, it may perhaps be said that it receives somewhat of the sensation of touch and taste. In short, Ranke holds these organs to be of such a kind that the general feeling is not yet fully separated into the categories of touch, hearing, seeing, &c.

The ear of the Pterotrachea had long been known as a bladder, on whose inner wall are tufts of hair, the motions of which throw to and fro the otoliths or small spherical stones freely suspended within the bladder. It was believed that these continuous motions were connected with the sensation of hearing. Ranke proves, however, that they are merely due to convulsive movements of the animal in dying under the observation, and that the acoustical apparatus proper consists of a ganglion in the bladder wall, organised similarly to that in the Acridia. In the normal condition, the otoliths are pressed by the surrounding hair tufts against the acoustical apparatus only in the case of stronger sound stimuli, and they have then a damping action.

NOTES FROM THE "CHALLENGER"[1]

PROF. THOMSON in this paper after briefly referring to a visit to the Hawaiian crater of Kilauea, proceeds as follows:—

In the section between Hawaii and Tahiti, except at one station close to Tahiti, where the depth was 1,525 fathoms, the depth ranged throughout the section from 2,000 to 3,000 fathoms with a mean of about 2,600 fathoms, and the nature of the bottom was very uniform. Except in the neighbourhood of the groups of volcanic islands where it was found to be largely composed of volcanic [illegible] and shore mud, it consisted mainly of red clay, in many of the soundings containing a large admixture of the decaying shells of Foraminifera, and in almost all including a large proportion of manganese peroxide in the form of concretions from the size of a nut to that of an *Orlulina*[illegible] and passing into fine almost microscopic granules visible under a low power in every sample of sounding. In two patches the siliceous skeletons of Radiolarians were so abundant as almost to entitle the deposit to the name of Radiolarian ooze; and a patch between these, nearly halfway between Hawaii and Tahiti, in its abundance of surface Foraminifera approached to true "Globigerina ooze". The larger samples of bottom brought up in the dredge or trawl had therefore usually the same character as the contents of the [illegible] tube, and [illegible] the large manganese concretions up to the size of an orange or even [illegible], were collected in quantity, the greater part of the red clay being [illegible] out.

The surface temperature rose gradually in our passage southwards from Hawaii towards the equator, and again [illegible] from the equator to [illegible] Tahiti. The isothermals between 14° C. and 2° C. gathered together and approached much nearer to the surface in the region of the trade winds [illegible] to the equatorial belt [illegible] [illegible] [illegible] and the [illegible] direction of the wind. [illegible] the isotherm of the line of 14° C., which is at a depth of 90 fathoms a little to the north of Tahiti is at a depth of 100 fathoms on the line. In the Atlantic all the isothermals seem to [illegible] in the region of the trade winds [illegible] the lines below 14° C. [illegible] which extends from lat. 10° N. to lat. 10° S. [illegible] 5° C., which may be taken as a type of these [illegible] lines, is found in lat. 10° N. at a depth of 450 fathoms, and in lat. 10° S. at the same temperature within the limit of error of observation, while in lat. 2° 3' N. it is found at 675 fathoms. The point where the isothermals gather together most markedly and approach nearest to the surface is [illegible] the [illegible] of the [illegible] of the [illegible] counter current. This fall of temperature is so decided as to indicate some [illegible] of cold water, and it may possibly be due to some extent due to the [illegible] up of deeper and therefore colder layers of the colder [illegible] current [illegible] the [illegible] stream. In the equatorial region between lat. 10° N. and 10° S. there is a belt of water about 80 fathoms in thickness at a temperature generally over 25° C., and the whole of this water, with the exception of the narrow band of the counter current, is running to the westward at the rate of from forty to twenty miles a day.

The bottom fauna over the whole of the [illegible] area is very meagre both as to number of species and number of individuals.

After a week's stay at Tahiti the *Challenger* left the harbour of Papeete on the 3rd of October and arrived at Valparaiso on the 19th.

[1] Preliminary Report to the Hydrographer to the Admiralty on some of the Results of the Cruise of H.M.S. *Challenger* between Hawaii and Valparaiso. By Prof. Wyville Thomson, F.R.S., Director of the Civilian Scientific Staff. Communicated by the Royal Society.

[illegible] The words *[illegible]* [illegible] are here used to [illegible] lines of equal temperature [illegible] of the earth [illegible] [illegible] the [illegible] *[illegible]* are [illegible] the [illegible] [illegible] drawn through points of equal temperature in a vertical section, and the latter, lines drawn through points of equal depth at which a given temperature occur. Isothermolaths are shown in a scheme of a vertical section such as Plate II. Isobathytherms are of course projected on the surface of the globe.

The section from Papeete to Valparaiso (Plate III) is about 5,000 miles in length, and is naturally divided into two parts, the run southwards to the parallel of 40° S., and the course along that parallel towards Valparaiso.

Setting aside Station 279 in 680 fathoms close to Tahiti, the mean depth throughout the section was 2,139 fathoms, considerably less than that of the meridional section from Honolulu to Tahiti, and very much less than that of the section in the North Pacific, between Japan and San Francisco. The nature of the bottom is very much the same as in the meridional section, red clay imbedding nodules, and lumps of various sizes of manganese peroxide, and passing in the shallower soundings into more or less pure Globigerina ooze, and as in the section between Hawaii and Tahiti the fauna is generally meagre. The trawling between Juan Fernandez and Valparaiso (Station 298) was particularly interesting, animal forms were much more abundant than they usually are in the Pacific, and the general character of the assemblage resembled in a remarkable degree that of the fauna of the Southern Sea in the neighbourhood of the Crozets and Kerguelen, many of the species, including some singular Urchin of the family Ananchytidæ, being identical. The bottom at this station was a bluish mud, the surface layer containing little or no carbonate of lime, and curiously enough a deeper layer, with a considerable proportion of Globigerina shells. There was no considerable quantity of manganese in the sounding. Notwithstanding the considerable depth of 2,225 fathoms, the conditions in this locality seem much more favourable to animal life than even the manganese area, and I am inclined to think that we had struck upon one of the highways by which migration takes place to the northward from the Southern Sea.

Although there are certain points which have yet to be worked out in detail, the general distribution of temperature in the Pacific seems sufficiently simple. In the first place, the whole mass of water consists of two well marked divisions, an upper layer of no great depth, in which there is rapid cooling from the surface downwards, and considerable variation in temperature in different localities; and a mass of water of incomparably greater amount, which extends to the bottom, and which may be said to have nearly the same temperature throughout. These two divisions shade into one another, but the isothermobath of 5° C. may be taken as indicating generally the limit between them, below this line the isothermobaths are still affected by surface thermal conditions, but comparatively slightly. Above the line of 5° C. the course of the isothermobaths is to all appearance entirely regulated by causes affecting the surface temperature, that is to say directly or indirectly by surface currents produced by permanent, periodic, or variable winds. The equatorial current occupies the region of the trade winds, approximately from lat. 20° N. to 20° S., and there is a strong but narrow counter current entirely comparable with the counter current in the Atlantic between the parallels of 5° and 8° N. The water of the equatorial current has no free egress to the westward, being intercepted by the peninsula of Malacca and the islands of the Malay archipelago, but neither is it completely arrested, as the equatorial current is in the Atlantic by the unbroken coast of America, consequently a return current less permanent and less defined than the return current in the Atlantic finds its way to the north-eastward along the coast of Japan. The course of the Japan current is much the same as that of the Gulf-stream, and is due, as in the Atlantic return current, to the high initial velocity of the intercepted water, its influence on the temperature of the ocean is, however, much sooner reduced and obliterated.

The hot water of the Pacific equatorial current, instead of being gathered together and focussed by the form of the land-barrier, as it is in that of the Atlantic, spreads out in the middle and West Pacific in a vast sheet of abnormally warm water, extending to a depth of nearly 100 fathoms, thus the isobathytherm of 25° C. at 80 fathoms passes near Hawaii and Tahiti, and near the parallel of 20° N. on sections between the Admiralty Islands and Japan. The lower isothermobaths of the upper layer are a little nearer the surface in lat. 40° N. than in lat. 40° S.; and this I believe to be due to the banking of the Antarctic indraught against the Arctic land-barrier, and to be the only case in which the position of the lines of equal temperature in the upper layer is not absolutely dependent upon the wind.

The temperature of the underlying cold water is derived from another source, and its distribution is governed by other laws. Throughout the Pacific the isothermobath of 5° C. maintains on the whole a very even course, oscillating between the 400 and 500 fathom lines. These oscillations depend upon causes acting on the surface, for the line rises and falls in harmony with the higher isothermobaths. The line of 5° C. deviates sensibly on two occasions from its comparatively straight course. In the equatorial region it sinks to a depth of 625 fathoms, probably from the communication of heat from the upper layer of water by mixing; and in lat. 40° it rises to 300 fathoms, probably, as I have already said, from the accumulation of cold water against the Arctic barrier. The next three degrees of temperature are lost with increasing slowness in the next 700 fathoms, the line of 2° C. making a very even course at a depth of 1,100 fathoms, and the remaining degree or degrees and a fraction being lost between 1,100 fathoms and the bottom. The depth of the Pacific increases slowly from the south to the north, the mean difference between the depth of the South Pacific and that of the north being perhaps as much as 1,000 fathoms. Notwithstanding this increase in depth, we have satisfied ourselves, although the determination is one of great difficulty, that the bottom temperature rises slightly from the south northwards. We can scarcely say more than that it rises slightly, for the differences in the temperatures below 1,500 fathoms are so small that a result can only be arrived at by a careful combination and comparison of many observations, taking into full consideration the errors of the thermometers arising from all sources. There is a like very slight decrease in the bottom temperatures from east to west.

I think we can scarcely doubt that like the similar mass of cold bottom water in the Atlantic, the bottom water of the Pacific is an extremely slow indraught from the Southern Sea. That it is moving, and moving from a cold source, is evident from the fact that it is much colder than the mean winter temperature of the area which it occupies, and colder than the mean winter temperature of the crust of the earth; that it is moving in one mass from the southward is shown by the uniformity of its conditions, by the gradual rise of the bottom temperatures to the northward, and by the fact that there is no adequate northern source of such a body of water, Behring's Strait being only forty fathoms deep, and a considerable part of that area being occupied by a warm current from the Pacific into the Arctic Sea, and by our knowledge from observations that one or two trifling currents from the Sea of Okotsk and the Behring Sea, which are readily detected and localised, and are quite independent of the main mass of cold water, represent the only Arctic influx. During its progress northwards the upper portion of the mass becomes slightly raised in temperature by mixing with, and possibly by slow conduction from, the upper layers which are affected by solar heat. At the end of the Gulf, that is to say in the extreme north, furthest from the cold source, the temperature is, as I have already pointed out, influenced to the very bottom, and the isothermobaths between 8° and 5° C. are obviously raised and pressed together, probably by the accumulation of the cold water against the land. The colder bottom water to the westward might be expected from the lower initial velocity of the Antarctic water causing it to drag against the west coast.

I am every day more fully satisfied that this influx of cold water into the Pacific and Atlantic oceans from the southward is to be referred to the simplest and most obvious of all causes, the excess of evaporation over precipitation in the northern portion of the land hemisphere, and the excess of precipitation over evaporation in the middle and southern part of the water-hemisphere.

After what I have already said I need scarcely add that I have never seen, whether in the Atlantic, the Southern Sea, or the Pacific, the slightest ground for supposing that such a thing exists as a general vertical circulation of the water of the ocean depending upon differences of specific gravity.

NOTES

The forty-seventh anniversary of the Zoological Society was held on Saturday last, Viscount Walden, F.R.S., the President, being in the chair. Mr. P. L. Sclater, F.R.S., the Secretary, read the report, which showed that the income (28,757) was greater than it had been in any previous year since the foundation of the Society. The total number of visitors in 1875 had been 699,918. The new lion house had been, as far as its main portions were concerned, completed and opened to the public. The building contains fourteen dens, the

larger of which measure 20 ft. by 12 ft., the smaller being 12 ft. square. The out-door cages are to be completed by the end of July next; they will measure 44 ft. by 29 ft. Mr. Sclater desired it to be known that of the larger Felidæ, the Ounce (*Felis uncia*) was a desideratum. The adoption of the report was moved by Prof. Huxley, seconded by Prof. Tennant, and carried unanimously.

OUR readers will regret the very sudden death of Lieut. J. E. Cornelissen, which occurred at Brussels in the month of March. Those who enjoyed the pleasure of his acquaintance will remember the hearty sailor-like demeanour of the man, while all who have paid attention to maritime meteorology will be ready to recognise his high scientific merits and the practical turn of mind which made the marine publications of the Utrecht Institute so eminently useful to seamen. He had been for sixteen years at the head of the marine branch of that establishment, having succeeded Andrau. He leaves a wife and four children utterly unprovided for.

THE following are the names of the Commissioners appointed to inquire into various matters connected with the Scottish University:—Lord Justice-General Inglis, the Duke of Buccleuch, Lord Moncreiff, the Right Hon. Lyon Playfair, C.B., Sir William Stirling Maxwell, James Craufurd, one of the Senators of the College of Justice in Scotland, William Watson, her Majesty's Solicitor-General for Scotland, John Muir, D.C.L., James Anthony Froude, Archibald Campbell Swinton, LL.D., Prof. Huxley, Dr. James Alexander Campbell, LL.D.

WE learn from the *Illustrated Australian News*, of Feb. 23, that a party consisting of Mr. Lawes, M. O. C. Stone, F.R.G.S., Mr. Hargreave, of Sidney, and Mr. K. Broadbent, bird collector, together with several Southsea Islanders, have made a successful excursion into the interior of New Guinea from Port Moresby. They attained a village called Munikaihila, situated 1,000 feet above the sea-level, and were well received by the natives. The view from this point was very fine. "All around were mountains and hills of every shape and size, covered with trees to the very summits," and Mount Owen Stanley rose as a grand background to the panorama apparently about twenty miles distant. We shall no doubt shortly receive a notice of Mr. Broadbent's discoveries.

WE have much pleasure in noting that in the monthly publication of tri-daily meteorological observations issued from Vienna, Dr. Jelinek has this year included two stations the observations at which, in addition to their climatological importance, cannot fail to be of the greatest value in constructing weather-maps, viz., Sulina, near the mouth of the Danube, and Alexandria, in Egypt.

IN a further discussion of the temperature observations made at the Museum of Natural History, at Paris, the MM. Becquerel point out that the mean temperature of the soil under grass is a little in excess of that under bare soil, and that under grass the temperature has not fallen below 32°, a fact of some importance in horticulture.

PROF. NORDENSKJOLD is to leave Gothenburg, on July 10, in a steamer of 163 tons for another cruise to the mouth of the Jenesei. He will sail up the river as far as Dudinko, when the steamer will take merchandise on board and return to Norway, the object of this expedition being to prove that there is a maritime route between Norway and the Siberian coast. We learn from *L'Explorateur*, moreover, that a Russian steamer is to leave the Jenesei and proceed to St. Petersburg by the Kara Sea, the North Sea, and the Baltic.

M. MARIE DAVY, the Director of the Montsouris Observatory, is to try whether Crookes's rotating radiometer can be utilised for actinometric purposes. No establishment is in a better position to try the experiment, Montsouris being supplied with regular actinometers, and special tables having been calculated for regulating as far as possible, their daily use.

IT is announced that Sir Bartle Frere is to be made a baronet.

THE Queen has conferred upon Lieut. Cameron—who was presented to her Majesty last Friday—the honour of Companion of the Bath, in recognition of his distinguished services in Africa.

AT the Annual Meeting of the Royal Institution on Monday, a piece of plate and a purse containing 300 guineas, were presented to Prof. Tyndall as a testimonial of congratulation on his recent marriage.

DURING the siege of Paris experiments were tried to make use of the conductibility of the Seine in order to establish communications with the outer world in spite of the Prussian blockade. Paris, however, surrendered before the apparatus had been arranged on the Upper Seine. This scheme has not been totally abandoned, and M. Bourbouge a *preparateur* of the Sorbonne has tried to establish the telegraph without wire. According to M. Parville, the plan has succeeded at a small distance by expending a large quantity of electricity, not less than forty elements being required to work a magnetic needle at a distance of a quarter of a mile. The same experimenter is said to collect spontaneous currents from the earth with large electrodes. The interest of these experiments is unquestionable.

FROM the "Annual Report upon the Survey of Northern and North-western Lakes, in charge of C. B. Comstock, Brigadier-General, U.S.A.," we learn that the triangulation has been carried around the south end of Lake Michigan, and stations have been located for its extension south and east toward Lake Erie. On Lake Ontario the topography has been essentially completed from the head of the Saint Lawrence along the south shore to within twenty miles of the Niagara River, and the off-shore hydrography has made about the same progress. Triangulation-stations have been located as far west as Erie, Pa. and have been built as far as the Niagara River. Charts of Lake Saint Clair, and No. 2 of the Saint Lawrence River are completed. It is proposed during the present fiscal year to complete the field-work of the survey of Lake Ontario and commence that of Lake Erie In the estimate of $184,000 for the survey of the lakes for the next fiscal year, an item of $25,000 has been included for the survey of the Mississippi River. No complete and accurate survey of the river has ever been made.

PART I., No IV., for 1875, of the *Journal of the Asiatic Society of Bengal*, contains papers on the Angámi Nágas and their language, by Capt. J. Butler, on the Maiwár Bhils, by Mr. T. H. Hendley, and specimens of popular songs of the Hamirpur District, Bundelkund, by Mr. F. A. Smith.

THE fifth part of the Bulletin of the Bussey Institution of Harvard University for 1876, completing vol. i., has just been published, and contains a number of valuable papers, principally by Prof. Storer, Dr. Farlow, and Mr. Sargent. Dr. Farlow's papers treat of the fungi found in the vicinity of Boston, of the olive and orange trees of California, of the American grape-vine mildew, and of the black knot. Mr. Sargent reports the addition of 165 species of trees and shrubs to the arboretum during the past year, and that over 100,000 plants have been raised. The papers of Prof. Storer, as usual, are of much scientific value.

ON the 10th of January last, Mr. Lancelot Studdert, LL.D., read a paper before the Royal Irish Academy (since published in the *Proceedings* of that learned body) on "The free and

albuminoid ammonia yielded by the stagnant waters of the Dublin streets, as compared with the quantities of those substances obtained from the Liffey water receiving the sewage." Twenty-nine street waters were examined; the mud, also, left from some was examined for ammonia. The following are Dr. Studdert's deductions:—The average of free ammonia from the four samples of the river was 0·0982, or under 1-10 of a grain in the gallon; the average of albuminoid ammonia from the same is 0·0779, or under 1-12 of a grain in the gallon. The average of free ammonia obtained from the twenty-nine street waters is seventeen grains to the gallon, that is, over 170 times the like average from the river. The average of albuminoid ammonia from the street water is three grains to the gallon, or thirty-eight times the Liffey average. The maximum of free ammonia from the river only reached 0·175, or less than 1-5 of a grain to the gallon, whilst the maximum of free ammonia from the street waters was 105 grains to the gallon, that is exactly 600 times greater than the river maximum. The least impure of the twenty-nine street waters yielded nearly three times more albuminoid ammonia than the most impure sample of the river water. The average of disintegrating animal refuse in the Liffey is 0·779, or just 3-4 of a grain in the gallon, whilst the average of such refuse in the street waters is twenty-nine grains to the gallon. That much of this animal matter must, if not rapidly removed, take forms that will vaporise, seems to the writer all but certain, since the conditions for spontaneous decomposition may be said to be always present; and he concludes that the continued presence of so much dirt in the streets would go far to account for the high death rate (33 to the 1,000, yearly), then lately recorded for Dublin, and that better scavenging and a level surface for the streets are at once required.

THE proposal for establishing a mountain exploration club in America, with similar objects to the Alpine clubs of England and Switzerland, is meeting with a good deal of encouragement, and several meetings have been held for the purpose of organising it.

MR. BRYCE M. WRIGHT, of No. [illegible] Great Russell Street, Bloomsbury, has just received [illegible] a perfect specimen of fossil Turtle (*Chelone hoffmanni*) from the Upper Chalk of Maestricht. It is 4 feet 1 inch in length and [illegible] inches wide, more than twice as large as the largest English specimens from Harwich and Swanage, Dorset, and is indeed the largest known.

THE correspondent J. C. who last year sent us a query concerning the cause of death of the house fly, writes that recently he noticed that a humble bee had five small animals like yellow spiders on its neck, and two more on its body. He had previously noticed a number of hive bees lying dead on the greenhouse floor. Another correspondent explained that the death of the fly was caused by parasites, and J. C. wishes to know if those on the bee are the same, and if they cause the death of bees as well as flies.

THE Lord Mayor and the Lady Mayoress will entertain the President of the Royal Society, the Astronomer Royal, the Presidents of the Royal Colleges of Physicians and Surgeons, and other distinguished representatives of science, at a grand banquet in the Mansion House, on Saturday-week, the 13th instant.

THE opening meeting of the Northamptonshire Natural History Society and Field Club was held at Northampton on April 21, Lord Lilford in the chair. This Society starts under good auspices, with a roll of sixty members, and we hope it will soon get into vigorous working trim.

IT is officially announced that the Philadelphia Exhibition will be opened on the 10th instant.

THE additions to the Zoological Society's Gardens during the past week include two Bennett's Cassowaries (*Casuarius bennetti*) from New Britain, presented by the Rev. George Brown; an Indian Gazelle (*Gazella bennettii*) from India, presented by Lieut. King, 76th Regiment; a Common Badger (*Meles taxus*) European, presented by Mr. W. P[illegible]; a Dusky Ichneumon (*Herpestes pulverulentus*) from India, a Narrow-fronted Crocodile (*Crocodilus frontatus*) from W. Africa, presented by Dr. Alex. Jennens; four Black-headed Sternotheres (*Sternothaerus subniger*) from Madagascar, presented by Mr. Lionel Hart; two Protei (*Proteus anguinus*) European, presented by Sir [illegible]; a White-fronted Capuchin (*Cebus albifrons*) from S. America; a White-throated Capuchin (*Cebus hypoleucus*) from Central America, a Lyre Bird (*Menura superba*) from Australia, a Hoffmann's Sloth (*Choloepus hoffmanni*) from Panama, three Common Boas (*Boa constrictor*) from S. America, deposited; a Collared Fruit Bat (*Cynonycteris collaris*) born in the Gardens.

SCIENTIFIC SERIALS

Journal of the Chemical Society, No. clix., March 1876.—This number contains a lengthy account of the researches of Dr. Wright and Mr. G. H. Beckett on narcotine, cotarnine, and hydrocotarnine, being the third of a series of papers read by them before the Chemical Society on their researches in this direction. Mr. E. Neison gives an account of the sebates of the alcoholic series and an additional note on the sebate of cobalt.—A paper by Mr. J. J. [illegible], B.Sc., on some compounds of ether with anhydrous metallic chlorides, and one by Mr. R. W. Emerson MacIvor, on the iodides of antimony, complete the list of those papers read before the Chemical Society.—Numerous abstracts of papers published in other journals on various branches in the different departments of chemistry occupy the greater part of the work now before us.

Gazzetta Chimica Italiana, Fascicolo IX. e X., Anno V., 1875.—These parts contain the following papers:—Action of anhydrous chloral, and of the hydrate, on aniline, by D. Amato. The author has obtained by this reaction a new base formed according to the equation

$$CCl_3COH + 2C_6H_5NH_2 = H_2O + CCl_3CH\begin{cases}NHC_6H_5\\NHC_6H_5\end{cases}$$

Chloral. Aniline. New base.

The new substance forms [illegible] tabular crystals melting at [illegible], soluble in alcohol, ether, and benzene, and insoluble in water. Distilled with excess of potash it yields phenyl-cyanide:

$$CCl_3CH\begin{cases}NHC_6H_5\\NHC_6H_5\end{cases} + 5KHO = 3H_2O + 3KCl + 2C_6H_5CN$$

The author describes also the hydrochloride $CCl_3CH(NHC_6H_5)_2HCl$, and the platino-chloride $[CCl_3CH(NHC_6H_5)_2HCl]_2PtCl_4$.—Study of essence of Cubebs, by A. Oglialoro. The author shows that this substance contains: (1) a small quantity of a hydrocarbon $C_{10}H_{16}$, boiling at 158–163°; (2) A hydrocarbon $C_{15}H_{24}$, boiling at 264–265°, forming with hydrochloric acid the compound $C_{15}H_{24}2HCl$; (3) A hydrocarbon boiling at 262–263° not forming a compound with HCl, the composition of which is at present doubtful. The action of these hydrocarbons on the polarised ray is also described.—On the natural poison of the extract of human bodies, by Prof. A. Moriggia and A. Battistini. The remainder of the part is occupied by extracts from foreign journals.

Poggendorff's Annalen der Physik und Chemie, Ergänzung Band vii. Stück 3.—In a paper in this number on the magnetism of steel bars, by M. Fromme, it is shown that the temporary magnetism increases at first more slowly, then more quickly, and again more slowly than the magnetising force. M. Fromme also got the interesting result that when the remanent magnetism, through repeated action of a force P, has reached its limit, (the saturation corresponding to this force) a smaller force p, is not capable of altering it. For every permanent magnetisation of a steel bar there are, from zero onwards, a series of magnetising forces, in relation to which the bar has the properties of a bar of soft iron (without coercive force). Exact determinations were made of the function of magnetisation for forces having this effect; and it is shown that the Neumann-Kirchhoff developments on this subject cease to hold good as soon as the steel is permanently magnetic. M. Fromme further finds that the temporary magnetism of a steel bar with repeated magnetisation by a constant current, decreases, but in such a way that the whole magnetism

remains unchanged; thus, what is gained in remanent magnetism is lost in temporary.—Dr. Dibbit observes that ammonium-sulphate, ammonium-oxalate, and ammonium-acetate, in boiling solution, are partly decomposed, on addition of equivalent quantities of the chloride or the nitrate of potassium, sodium, or barium; that decomposition is greater, the greater the quantity of chloride or nitrate added; and that in all cases the solution contains, at 100°, four salts. From other experiments he infers that the presence of salts in ammonia solution increases the quantity of evaporated ammonia in relation to the evaporated water (even where the salts are such as enter into known combinations with ammonia), and this both at the ordinary and at the boiling temperature.—M. Holtz calls attention to the polar electric attraction of fine particles suspended in liquids when under the influence of electric currents. There is always, along with the movements of translations, an attachment to one pole or the other; very well seen with lycopodium powder in sulphuric ether. Some substances seem indifferent, neither wandering nor clinging to the poles, but if the bottom of the vessel be clean and free from air moisture, they form into beautiful, regular, characteristic figures. These may be had, *e.g.*, with finely-powdered manganese, or iron oxide, or sawdust, in petroleum, oil of turpentine, benzine, or sulphuric ether. The figures are rarely long stable; they show various internal movements, not essentially altering the character of the figure; and there is sometimes rotation.—M. Sohncke advances a new theory of crystalline structure, based on unlimited regular point systems; and Dr. Exner gives an account of his recent researches on galvanic expansion of metallic wires; which are noticed elsewhere in our columns.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Jan. 15.—Dr. Mohn contributes an article to this number on the causes of the greater depressions of the barometer in winter than in summer. His present views on this subject are different from those given in his work on meteorology. He explains that in order that a barometric minimum may attain a great depth, the ascending current must develop itself with ease and rapidity. Therefore, besides high temperature and a large amount of vapour, the air supplying the ascending current must possess qualities unlike those of the surrounding atmospheric region, so that the ascended air may flow off easily at great heights. The easier barometric maxima can be formed, the easier the development of minima. In winter the strong continuous radiation over the Continent tends to create maxima; the cooling of the air over the sea is moderated by the quantity of vapour always present and by the ocean temperature, so that minima are formed. In summer opposite conditions prevail, but no nightly radiation comparable to that of the land in winter can occur, and thus only small depressions are observed. In a similar way the low pressure of the antarctic zone between lat. 70° and lat. 75° may be understood to be caused by the position of this region between two districts with high pressure, the one northwards about the tropic of Capricorn, the other the great Frozen Antarctic Continent. Between these two maxima lies an unbroken sea developing conditions favourable to the existence of minima.—The next paper is by Dr. G. Hellmann, on the daily period of rainfall at Zechen.

Journal de Physique, January.—The substances used in thermometers are generally such as are not in the neighbourhood of their change of state; but (as M. Duclaux here shows) by using liquids that are near critical periods, very sensitive instruments may be had. Thus, if we mix 10 c.c. of crystallisable acetic acid with 5, 10, 15 c.c. of benzine at about 20° we have, in each case, a homogeneous mixture; and in cooling the three liquids we come, with each, to a point at which it is troubled, and at length divides into two layers. The upper layer is found nearly always to contain one-third of acetic acid for two-thirds of benzine; while the lower contains two-thirds of acetic acid and one-third of benzine. There are few combinations of *two* liquids that show small variations so distinctly as this one (acetic acid and petroleum is another). But a good mixture may be had by taking 10 c.c. of amylic alcohol, 25 c.c. of alcohol at 50°, and adding enough water to produce a slight opalescence. The least fall of temperature divides the mixture into two layers of nearly equal volume. Such a mixture will serve to show, *e.g.*, the cold produced by solution of marine salt in water. By varying the quantity of water the mixture may be so made as to become troubled at any temperature desired; and so a series of minimum thermometers may be constructed. A little carmine may be used to make the changes more apparent.—M. Deprez, in this number, gives some useful directions on the construction of electro-magnetic registers; and M. Branly describes the electrometer he uses for measuring electromotive force, resistance, and polarisation.

SOCIETIES AND ACADEMIES

London

Chemical Society, April 28.—Prof. Andrews, F.R.S., delivered a most interesting lecture on certain methods of chemical research (see p. 12).

Anthropological Institute, April 25.—Col. A. Lane-Fox, president, in the chair.—Dr. Comrie, R.N., exhibited his collection of weapons and articles of domestic use from New Guinea, and added several particulars to his previous remarks.—Mr. A. Tylor, F.G.S., read a paper on the origin of numerals. He held that inventive thought had always an object origin, and mentioned measures of length, as pace, foot, hand, &c., as having such a source. Also in the Ptolemaic hieroglyphics, a minute or second was shown by an eye-winking, answering to "the twinkling of an eye." Illustrations of the Abacus and mode of calculating by it were exhibited, and shown to be in principle the origin of the modern calculating machine. The dream of a universal language has been realised, as far as numerals and arithmetical figures are concerned, and this is due to their origin.—A paper by Mr. A. L. Lewis was read on some apparent coincidences of custom and belief in Chaldæa and other countries. He alluded, amongst other points, to the marks of finger-nails upon the terra-cotta deeds that had been discovered at Nineveh. They appeared to him to answer to the practice of touching the seals of legal documents with the finger. As regards the belief of the Assyrians in immortality, souls were either united with the sun, or descended to "Bit-Edie." Annwn, the country of the dead, in like manner amongst the Kymry was situated in the lower regions, at the going down of the sun in the west. The children of Anu, or the Sky, in Assyria, may be compared with "Cum Annwn," spirits, believed in by the Kymry. Amongst the Assyrian gods, Hed answered to the Lycian deity "Hu." Civilisation appeared to originate with the Turanians, the Semitic race merely succeeding to it.—The President, Mr. A. Smee, Mr. Distant, and others, took part in the discussion.

Physical Society, April 29.—Prof. Gladstone, vice-president, in the chair. The following gentlemen were elected members of the Society: Prof. F. Fuller and Capt. L. H. White.—The Secretary read a communication from Sir John Conroy, Bart., on a simple form of heliostat. The defect of Fahrenheit's heliostat, in which the beam of sunlight is deflected by a mirror moved by clock-work in a direction parallel to the axis of the earth, and then in the required direction by a fixed mirror, consists in the great loss of light. The author substitutes two silvered mirrors for the looking-glasses usually employed, and he has shown that the loss of light with this arrangement is less than when the light is once reflected from a looking-glass.—Mr. S. P. Thompson then made a second communication on the so-called "Etheric Force," and described some experiments which he has recently made in the Physical Laboratory at South Kensington on the subject. The name was given by Mr. Edison, the inventor of the motograph, to the sparks obtained when a conductor is presented to the core of an electro-magnet, the coils of which are traversed by an intermittent current. The results of the experiments conducted as originally described not proving satisfactory, various other arrangements were tried, and it was found that if the secondary current from an induction coil be used, instead of a current direct from the battery, the effects are much more marked. When the induced spark was diverted either wholly or partially into a short coil which was insulated very perfectly from the core inside, a spark about half an inch in length, which had a decided effect on the nerves could be drawn off from the core, and this was sufficient to illuminate a small vacuum tube; the spark, however, does not exhibit the usual signs of polarity. It was shown by observing the illumination thus produced with a rotating mirror, that the discharge is in reality a reciprocating one, each spark returning on its path after a minute interval of time. Under certain conditions it is also possible to charge an electroscope either positively or negatively by means of the spark, and Mr. Thompson has shown that the spark ignites a jet of gas but fails to deflagrate metallic wire or ignite gunpowder. From the above, and other

THURSDAY, MAY 11, 1876

THE LOAN COLLECTION

THE Queen will on Saturday open to the public the magnificent collection of scientific instruments, the arrangement of which has for several months been tasking the energies of the Science and Art Department and of the eminent men of science who have generously volunteered their assistance. This event may justly be regarded as an "epoch-making" stage in the progress of science, not only in this country, but in the world at large; for, as our readers know, the collection is essentially an international one, the principal nations of the world having vied with each other in contributing to render it worthily representative of the present state of science, and of the progress of its methods from the time when man first began feebly to question Nature. England may well be proud that the idea of such a collection originated with the English Science Department, and that the first international scientific loan collection will be exhibited in her capital. It may be that this collection will not attract such a crowd of visitors as would flock to gaze on an exhibition of pictures, or musical instruments, or embroidery, or old china; but, if the British public still retains its normal amount of curiosity, surely the magnitude of the present collection, the historical interest attaching to many of the objects exhibited, the number and eminence of the contributors, and the fact that the principal governments of Europe have enthusiastically seconded the efforts of the British Government, ought to excite that curiosity to the utmost. A great deal of mystery still hangs about science and scientific men and scientific methods in the eyes of many; here then at last have people an opportunity of inspecting for themselves these mysterious instruments by means of which men of science have reached those results that are stirring the minds of all thoughtful men, and have revolutionised ideas and methods in all departments of human activity. Englishmen must be duller and more incurious than we take them to be, if they do not show a fair amount of interest in that scientific collection which her Majesty will open on Saturday.

But while many, no doubt, will be attracted to the galleries of the International Collection by mere curiosity, we are sure that the scientific education of this country is sufficiently advanced to secure a large proportion of visitors animated by an intelligent and educated eagerness to gratify their scientific tastes by inspecting apparatus the importance and uses of which they are well enough taught to appreciate. Both to this latter class and to those who still lie in unscientific darkness, the two thick volumes [1] which have been issued—prepared at the request of the Lords of the Committee of Council on Education—as guides to the Loan Collection ought to be a welcome boon. Some idea of the extent of the collection may be obtained from the fact that these two volumes together number nearly 1,000 pages, and they are both at present incomplete. With these in his hands as guides no visitor need go empty away from the collection. A careful perusal of these two volumes combined with a systematic series of visits to the various sections of the collection, would, like the acquaintance of a certain noble lady, be in itself a liberal education; and indeed few better methods could be devised of rousing a love for science in the minds of intelligent people.

In two previous articles we have attempted to give a general sketch of the nature of the collection; in the present article we shall, with the two volumes referred to as guides, briefly give some idea of its extent and arrangement. The large Committee—and there is scarcely a scientific name of eminence absent from it—that met little more than a year ago at the request of the Lords of the Committee of Council on Education to confer on the organisation of a Loan Collection of Scientific Apparatus ought to be proud of the results of that first conference as embodied in these two valuable publications. The names on this Committee, and those on the Committees formed in foreign countries, number somewhere about 300; a glance at the lists shows that the names are those of the foremost scientific workers of our time. Specially gratifying must the result be to the staff of volunteers who have assisted in the arrangement of the collection, and whose names their Lordships justly record with "great satisfaction." They are: Capt. Abney, Dr. Atkinson, Mr. Bartlett, Dr. Brunton, Dr. Biedermann, Prof. Crum-Brown, Capt. Fellowes, Prof. Carey-Foster, Dr. Michael Foster, Herr Kirchner, Prof. Goodeve, Dr. Guthrie, Commander J. A. Hull, Mr. Iselin, Mr. Judd, Mr. Norman Lockyer, Dr. R. J. Mann, Mr. Clements Markham, Prof. H. MacLeod, Prof. Roscoe, Prof. Shelley, Dr. Burdon Sanderson, Dr. Schuster, Dr. Voit, and Mr. R. Wylde

Their Lordships, we should say, are particular in calling attention to the fact that this is not an International *Exhibition*; the purpose and arrangement of this collection are entirely different from those of such an exhibition, which is always arranged according to countries and into which the commercial element largely enters. The arrangement here, on the contrary, is according to subjects, and the object is solely to illustrate the history and present condition of scientific apparatus. The transport of all objects has been undertaken by the English Government, and they have been handed over absolutely to the custody of the Science and Art Department.

Prefixed both to the Catalogue and the Guide is a clear and useful plan of the buildings at Kensington, showing the arrangement of the apparatus in the various galleries. Fourteen galleries in all are occupied with the collection, embracing the ground floors of the entire south and west sides, and the upper floor of the latter. Entering, as the Queen will do on Saturday, by the entrance in Exhibition Road, we come first upon A, the Educational Collections; following which are B, C, Applied Mechanics; D, Naval Architecture and Marine Engineering; E, Lighthouse Apparatus; F, Magnetism and Electricity; G, Arithmetic and Geometry; H, K, Measurement; L, Astronomy and Meteorology; these are all on the ground floor. Ascending to the upper floor, we pass through M, Geography, Geology, and Mining; N, Biology; O,

[1] "Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum." First Edition.—"Handbook to the Special Loan Collection of Scientific Apparatus." 1876.

Conference Room; P, Chemistry; Q, Light, Heat, Sound, and Molecular Physics.

The number of exhibitors—governments, societies, departments, and individuals—amounts to about 1,000, and the collection contains altogether somewhere about 15,000 objects, arranged in this first edition of the catalogue, under 4,576 heads. The countries represented are the United Kingdom, Austro-Hungarian Empire, Belgium, France, Germany, Holland, Italy, Norway, Russia, and Switzerland. The list from Spain is not yet received, and the fact that America is occupied with her own Centennial Exhibition sufficiently accounts for her absence, though the American Government heartily sympathises with the object of the collection. In the catalogue the objects are arranged under twenty-one sections; the numbers enable the visitor at once to identify each object or group of objects, and in most cases the appended descriptions are sufficiently detailed to enable anyone to understand the purpose and construction of the apparatus. In many cases the descriptions are as minute as in a special text-book.

Under Section 1, Arithmetic, are described various Slide-rules, 19 in all, 26 Calculating Machines, including Babbage's famous "Difference Engine," which is described in considerable detail, besides some interesting and ingenious miscellaneous apparatus. Under Section 2 are classed instruments used in Geometrical Drawing, Instruments for tracing Special Curves, Models of Figures in Space, and a collection of Plücker's models of certain quartic surfaces, contributed by the Mathematical Society.

As might be expected in a collection of scientific apparatus, those connected with Measurement, Section 3, occupy a large space: there are upwards of 350 entries under this head, comprising, besides a variety of extremely interesting and curious special collections, apparatus for Measurement of Length (nearly 100 entries) of Area, of Volume, of Mass, of Velocity, of Momentum, of Force, of Work, of Angles, and of Time (80 entries); many of the objects in this section are of a remote antiquity, and not a few are connected with scientific discoveries of the highest importance.

Section 4, Kinematics, Statics, and Dynamics, is a very full and instructive one; it is impossible to give here anything like an idea of the nature and variety of the apparatus exhibited under this head. It contains 22 sub-sections and sub-sub-sections, including several of 'sGravesande's apparatus, apparatus illustrating the Mechanical Powers, Pendulums and Gyroscopes, Vibrations and Waves, Falling Bodies and Projectiles, and other departments of the very comprehensive section, including 54 Crank Trains, 50 Toothed-wheel Trains, and 67 Ratchet Trains.

To many, Section 5, Molecular Physics, will be intensely interesting; its six sections contain 110 entries; the Air-pumps and Pneumatic Apparatus alone numbering 44. Osmose Dialysis and Diffusion, Condensation of Liquids and Solids, and Hydrometers, are some of the other subjects illustrated here.

Sections 6, 7, and 8, Sound, Light, and Heat, are of course among the most important, the catalogue containing 410 entries under these heads. There are apparatus illustrating the Sources, Measurement, and Interference of Sound, and a variety of other phenomena, including Musical Sounds; in Section Light, under the head Selectors, there are 36 groups of apparatus connected with the Spectroscope, and 30 to illustrate Polarisers, besides Photometers, Radiometers, apparatus bearing on Reflection, Refraction, and Diffraction. Photography is a varied and interesting sub-section. The multitude of apparatus connected with Heat is classified under Sources of Heat, Thermometry (56 entries), Calorimeters, Pyrometers, Freezing Machines, Conductors, &c.

Sections 9 and 10, Magnetism and Electricity, are likely to prove two of the most attractive, as they are certainly among the most important. All departments of these subjects—and how varied they are even scientific men may be astonished to learn—are illustrated with great fulness; the number of entries in the Catalogue is 650, commencing with the greatest natural magnet yet known, weighing, with armature, 152 kilograms, sent by the Teyler Foundation, Haarlem, and concluding with a minute description of the Polar Light Apparatus, by Prof. Lemström. Of apparatus connected with Electricity the variety is astounding. Friction and Induction Machines, Galvanic Batteries (there are 32), Thermo-Electric Batteries, Induction Coils, Magnetic-Electric Machines, and other modes of producing Electricity or Electric Currents, are abundantly represented. So, also, apparatus for producing, collecting, observing, regulating, and measuring electricity; of Galvanometers alone there are 43. In the Electrical Section, no doubt the most attractive department to the general public will be that devoted to apparatus for the application of Electrical principles to practical purposes, illustrating, as it does, every stage in the progress of the Electric Telegraph. The Catalogue in this department contains 204 entries of Telegraphic apparatus alone, not to mention the various other applications of electricity to military and other purposes.

Astronomy, Section 11, is at the same time one of the oldest and one of the most popular of the sciences, and therefore the apparatus in the section will probably have more than an average number of visitors. The historical interest of this section is probably greater than that of any other, and it is significant of the importance attached by Italy to this Collection that she has parted with, even for a short time, those precious relics of Galileo that cannot fail to excite the veneration of all beholders. But besides these there are many other instruments of great historical interest, from the Suspension Astrolabrum, made in 1525, sent by Prof. Buys Ballot of Utrecht, down to the latest form of spectroscope, and a relief landscape of the moon. Celestial photography is largely represented, both by its instruments and results, and teachers will be much interested in the varied and ingenious apparatus that have been devised for the practical teaching of astronomy.

Of the multitude of objects in Section 12, Applied Mechanics, it would be impossible with our space to give any satisfactory idea. The catalogue contains under this head 470 entries in all, many of which, as indeed is the case in all the other sections, include a considerable number of separate pieces of apparatus. Of Prime Movers alone there are 66 groups, ranging through many forms from a collection of the Original Models of Steam Engines and other machines of James Watt, downwards.

Under the comprehensive head of Application of the Principles of Mechanics to Machinery, as employed in the Arts, the catalogue gives a description of 136 varieties of apparatus, from the first type-composing machine invented by Alex. Mackie, which comes from Dundee, down to the latest forms of link-work.

Chemistry, Section 13, is of course one of the most prominent and important sections in the whole collection. When we say that the catalogue contains 360 entries under this head, we give very little idea of the multitude and variety of objects which have been brought together to illustrate the methods and results of the all-pervading science. The first entry is the apparatus employed by John Dalton in his researches, and is accompanied by a long descriptive and historical notice by Prof. Roscoe. Cavendish, Davy, Faraday ("Original tubes containing gases liquefied by Faraday," must be an exciting entry to many chemists), Wollaston, are names attached to some of the apparatus of historical interest, of Models, Diagrams, Apparatus, &c., employed in teaching Chemistry there is no end, and all the infinite variety of special chemical apparatus is amply illustrated, there being upwards of 200 entries under this head, representing probably more than ten times that number of separate objects.

The rapid advances and present complexity and comprehensiveness of Meteorological science are shown by the catalogue to be illustrated with wonderful fulness in the collection. The endless variety of Barometers, Thermometers, Anemometers, Rain-gauges, Hygrometers, Self-recording Instruments, Ozonometers, and other apparatus used in meteorology, will excite the astonishment of all but specialists. The Scottish Meteorological Society is a large contributor in this section, and some of their intensely practical graphic results must appeal to the blindest utilitarian.

Geography is sure to be a popular section, and we can only say that in its various sub-divisions are objects calculated to rouse the interest of the most incurious. The methods, apparatus, and results of the various surveys of this country and of India are illustrated in the greatest detail, and now that the *Challenger* is nearing our shores, many will be curious to see some of the apparatus with which her important ocean-researches have been conducted. There is a vast variety of surveying apparatus with which Geography obtains her apparently simple results, and of Maps, Charts, and Plans of all kinds the list is endless. Everyone must inspect with very curious feelings the original Journals, Log-books, &c., kept by celebrated English navigators from Dampier downwards, not to mention the valuable MS. Maps of Livingstone and other celebrated explorers.

Geology, Mining, and Mineralogy, Sections 16 and 17, are well represented. They include Geological Instruments and Apparatus; Maps, Sections, Diagrams, &c., lent by the Geological Survey; illustrations of the Sub-Wealden boring; various Relief-maps and Models illustrating Geological Phenomena all over the world; Fossils and Specimens of all kinds, natural and artificial; Mining Instruments and accessories, including a case of 46 varieties of Safety-lamp; Blowpipe Apparatus; Minerals, Diagrams, Models of Crystals, &c.

The Section of Biology has 500 entries, embracing probably eight times that number of separate objects. Of microscopes and accessory apparatus, there are upwards of 150 from the Compound Microscope of Zacharias Janssen, spectacle-maker, at Middleburg, Netherlands, constructed about 1590, down to the latest and most complicated form of this now indispensable and powerful instrument. Then there are many specimens of the curious and ingenious apparatus employed in Physiological Optics, Weighing and Measuring Apparatus, Apparatus for investigating the functions of Circulation and Respiration, of Muscles and Nerves, and an endless variety of Diagrams, Models, Preparations, and other appliances for instruction in Biology. Wolf's Collection of 106 Original Water-Colour Drawings illustrating the new and rare animals in the Zoological Gardens will prove nearly as attractive as the originals themselves.

Under Educational Appliances, Section 19, there are apparatus for practical instruction in Science in every department, including a very fine and large collection of apparatus for instruction in Physical Science, contributed by the Committee of the Pedagogical Museum, Russia. This section contains upwards of 550 entries.

Last of all comes the Collection of Apparatus and Photographs illustrating Italian Science, more especially in the departments of Physics, Mechanics, and Astronomy. There are many objects here deserving special mention, but our space forbids further detail. We have already referred to Galileo's instruments, and besides these there are many others of great antiquity and of much interest in connection with the progress of scientific apparatus.

This rapid glance at the contents of the Catalogue will give but a faint idea of the rich feast in store for those who during the next few months will be attracted to the South Kensington galleries. To give anything like an adequate idea of the contents of the collection would take a long series of articles.

We have said that the Catalogue, even in its present incomplete and rough form, is something more than a mere list of titles; it is very largely descriptive. But something more was required to show the purpose and import and historical place of the multitude of separate instruments in the various sections. This want is supplied in the admirable Handbook, of 340 pages, consisting of a series of descriptive and historical articles on the various sections by some of the most eminent living British men of science. It will be enough if we give here the names of the authors and the subjects of which they treat. In value the Handbook should be put alongside the Admiralty Manual issued to the Arctic Expedition; though probably no such unique collection of scientific memoirs was ever before put within reach of the public. The first paper is by Prof. Clerk-Maxwell, being "General Considerations respecting Scientific Apparatus;" Prof. Maxwell has also a paper in his own special domain, Molecular Physics. Prof. H. J. S. Smith writes on "Arithmetical Instruments" and "Geometrical Instruments and Models." Prof. W. K. Clifford also contributes two papers, on "Instruments used in Measurements" and on "Instruments illustrating Kinematics, Statics, and Dynamics." Then there are papers by Dr. W. H. Stone, on "Acoustical Instruments," by Mr. W. Spottiswoode on "Optical Instruments," by Capt. Abney on "Photographic Printing Processes," by Prof. Tait on "Instruments employed in Heat Investigations;" two

papers by Prof. Carey Foster on "Magnetic Apparatus" and "Electrical Instruments;" a paper by Mr. J. Norman Lockyer on "Astronomical Instruments;" by Prof. Goodeve on "Applied Mechanics," by Prof. McLeod on "Chemical Apparatus and Products," by Mr. R. H. Scott on "Meteorological Instruments." "Geographical Instruments and Maps" are illustrated historically and descriptively in four papers by Mr. C. R. Markham, and one by Capt. J. E. Davis. Prof. Geikie treats of "Geology," Mr. Warington Smyth of "Apparatus used in Mining," Prof. Story Maskelyne of "Crystallography and Mineralogy," Prof. Huxley of "Instruments employed in Biological Research," and Mr. H. C. Sorby of "Microscopes." Is not this strong enough evidence of the genuine interest which British men of science take in this Loan Collection of Scientific Apparatus?

There is only one drawback to our joy in seeing this collection at last completed and ready to be thrown open to the public: it is after all only a "loan" collection, and in a few months must be disorganised, and the apparatus returned to their owners. We have some reason to hope, however, that this will not be the end of all the labours of the eminent men who have exerted themselves to make the collection a success; we are persuaded that in time it will be succeeded by a permanent collection, which will form a Science Museum on an equal footing with the other Museums supported by Government. The Introduction to the Handbook says:—

"The Lord-President of the Council, the Duke of Richmond, and the Vice-President, Viscount Sandon, in explaining the objects of the collection, took occasion to refer to the recommendations of the Royal Commission on Scientific Instruction, with regard to the creation of a Science Museum. Their Lordships stated their conviction that the development of the Educational and certain other Departments of the South Kensington Museum, and their enlargement into a Museum somewhat of the nature of the Conservatoire des Arts et Métiers in Paris, and other similar institutions on the Continent, would tend to the advancement of science, and be of great service to the industrial progress of this country."

We cannot doubt that neither Government nor the public, after having substantial evidence of the value and important results of a Science Museum in this Loan Collection, will rest satisfied until this country is at least on an equal footing in this respect with our neighbour France. It seems to us that a permanent Science Museum will be the natural outcome of the unexpectedly magnificent collection which the Queen will open on Saturday; it cannot fail to make the public at large conscious of a serious want which for long has been painfully felt by men engaged in scientific research, both pure and applied.

DIFFUSION OF GASES THROUGH ABSORBING SUBSTANCES

Ueber die Diffusion der Gase durch absorbirende Substanzen. Habilitationsschrift der Mathematischen und Naturwissenschaftlichen Facultat der Universität Strassburg, vorgelegt von Dr. Sigmund v. Wroblewski, erstem Assistanten am physikalischen Institute. (Strassburg: G. Fischbach, 1876.)

THE importance of the exact study of the motions of gases, not only as a method of distinguishing one gas from another, but as likely to increase our knowledge of the dynamical theory of gases, was pointed out by Thomas Graham. Graham himself studied the most important phenomena, and distinguished from each other those in which the principal effect is due to different properties of gases.

The motion of large masses of the gas approximates to that of a perfect fluid having the same density and pressure as the gas. This is the case with the motion of a single gas when it flows through a large hole in a thin plate from one vessel into another in which the pressure is less. The result in this case is found to be in accordance with the principles of the dynamics of fluids. This was approximately established by Graham, and the more accurate formula, in which the thermodynamic properties of the gas are taken into account, has been verified by the experiments of Joule and Thomson. (Proc. R. S., May, 1856.)

When the orifice is exceedingly small, it appears from the molecular theory of gases that the total discharge may be calculated by supposing that there are two currents in opposite directions, the quantity flowing in each current being the same as if it had been discharged into a vacuum.

For different gases the volume discharged in a given time, reduced to standard pressure and temperature, is proportional to—

$$\frac{p}{\sqrt{s\theta}}$$

where p is the actual pressure, s is the specific gravity, and θ the temperature reckoned from -274° C.

When the gases in the two vessels are different, each gas is discharged according to this law independently of the other.

These phenomena, however, can be observed only when the thickness of the plate and the diameter of the aperture are very small.

When this is the case, the distance is very small between a point in the first vessel where the mixed gas has a certain composition, and a point in the second vessel where the mixed gas has a quite different composition, so that the velocity of diffusion through the hole between these two points is large compared with the velocity of flow of the mixed gas arising from the difference of the total pressures in the two vessels.

When the hole is of sensible magnitude this distance is larger, because the region of mixed gases extends further from the hole, and the effects of diffusion become completely masked by the effect of the current of the gas in mass, arising from the difference of the total pressures in the two vessels. In this latter case the discharge depends only on the nature of the gas in the vessel of greater pressure, and on the resultant pressures in the two vessels. It consists entirely of the gas of the first vessel, and there is no appreciable counter current of the gas of the other vessel.

Hence the experiments on the double current must be made either through a single very small aperture, as in Graham's first experiment with a glass vessel accidentally cracked, or through a great number of apertures, as in Graham's later experiments with porous septa of plaster of Paris or of plumbago.

With such septa the following phenomena are observed:—

When the gases on the two sides of the septum are

different, but have the same pressure, the reduced volumes of the gases diffused in opposite directions through the septum are inversely as the square roots of their specific gravities.

If one or both of the vessels is of invariable volume, the interchange of gas will cause an inequality of pressure, the pressure becoming greater in the vessel which contains the heavier gas.

If a vessel contains a mixture of gases, the gas diffused from the vessel through a porous septum will contain a larger proportion of the lighter gas, and the proportion of the heavier gas remaining in the vessel will increase during the process.

The rate of flow of a gas through a long capillary tube depends upon the viscosity or internal friction of the gas, a property quite independent of its specific gravity.

The phenomena of diffusion studied by Dr. v. Wroblewski are quite distinct from any of these. The septum through which the gas is observed to pass is apparently quite free from pores, and is indeed quite impervious to certain gases, while it allows others to pass.

It was the opinion of Graham that the substance of the septum is capable of entering into a more or less intimate combination with the substance of the gas; that on the side where the gas has greatest pressure the process of combination is always going on; that at the other side, where the pressure of the gas is smaller, the substance of the gas is always becoming dissociated from that of the septum; while in the interior of the septum those parts which are richer in the substance of the gas are communicating it to those which are poorer.

The rate at which this diffusion takes place depends therefore on the power of the gas to combine with the substance of the septum. Thus if the septum be a film of water or a soap bubble, those gases will pass through it most rapidly, which are most readily absorbed by water, but if the septum be of caoutchouc the order of the gases will be different. The fact discovered by St. Claire-Deville and Troost that certain gases can pass through plates of red hot metals, was explained by Graham in the same manner.

Franz Exner [1] has studied the diffusion of gases through soap bubbles, and finds the rate of diffusion is directly as the absorption-coefficient of the gas, and inversely as the square root of the specific gravity.

Stefan [2] in his first paper on the diffusion of gases has shown that a law of this form is to be expected, but he says that he will not go further into the problem of the motion of gases in absorbing medium, as it ought to form the subject of a separate investigation.

Dr. v. Wroblewski has confined himself to the investigation of the relation between the rate of diffusion and the pressure of the diffusing gas on the two sides of the membrane. The membrane was of caoutchouc, 0·0034 cm. thick. It was almost completely impervious to air. The rate at which carbonic acid diffused through the membrane was proportional to the pressure of that gas, and was independent of the pressure of the air on the other side of the membrane, provided this air was free from carbonic acid. The connection between this result and Henry's law of absorption is pointed out.

[1] "Pogg. Ann," Bd. 155.
[2] "Ueber das Gleichgewicht u. d. Diffusion von Gasgemengen." Sitzb. der k. Akad. (Wien), Jan. 5, 1871.

The time of diffusion of hydrogen through caoutchouc is 3·6 times that of an equal volume of carbonic acid. The diffusion of a mixture of hydrogen and carbonic acid takes place as if each gas diffused independently of the other at a rate proportional to the part of the pressure which is due to that gas.

We hope that Dr. v. Wroblewski will continue his researches, and make a complete investigation of the phenomena of diffusion through absorbing substances.

J. CLERK MAXWELL

MACALISTER'S "ANIMAL MORPHOLOGY"

An Introduction to Animal Morphology and Systematic Zoology. Part I.—Invertebrata. By Prof. Alexander Macalister, M.B. (Longmans, Green, and Co., 1876.)

HOW many of those who are not of an extra systematic turn of mind, when they review their reading in any special line of research, have continually to regret that they have not had the industry to abstract as well as to classify the various monographs and papers they have perused, and to preserve them in a united form for future reference. Those of us who are zoologists may lay aside some of our misgivings on this score; for one among us, an exhaustive reader and an acute appreciator of the relative importance of facts, has so widely distributed his literary investigations, at the same time that he has made it a principle to keep a memorandum of those points which have most impressed him, that he has felt justified —quite correctly, as all his readers we are convinced will agree—in placing his compilation at the disposal of the scientific public. The volume on the Invertebrata, now before us, fills between four and five hundred closely printed octavo pages.

It is evident that a work constructed on the principles above indicated must be of too exhaustive and too abstruse a nature for the commencing student. It would be impossible for any author so to combine primary definitions and first principles with elaborate detail as to produce a book which would appeal to the tyro as well as the advanced zoologist. Prof. Macalister's "Introduction to Animal Morphology" must be therefore looked upon as an introduction to the science proper, to be read by the second-year student, or to be interleaved for further annotation by the specialist. To teachers of Zoology it will be found invaluable on account of the great fund of information it contains in a highly condensed form, also because in nearly all cases the *name* of the authority for each important fact is associated (in brackets) with his observation. In such a work we think that no better method could have been employed. It would have greatly overloaded the pages if full references had been given; and now that the invaluable Catalogue of Scientific Papers, published by the Royal Society—in which the publications are arranged under the *names* of authors—is within reach of all, in the libraries of the learned societies, if not elsewhere, it is a matter of no great difficulty for anyone who is particularly interested in any special detail, to find which is, and refer to, the monograph or shorter communication in which the point in question is embodied.

There is a small detail in association with the printing of the work, a modification of which in the second volume

would be an immense advantage. Prof. Macalister heads each page with the words, "Introduction to Animal Morphology." In so doing he seems to have entirely overlooked the fact that the object of the heading is to give some notion as to what is to be found below it, and not the title of the work itself. Why he has not followed the ordinary method of placing on the top of one of each two pages the subject of the chapter, and on the other further detail, we are at a loss to understand, and suffer accordingly in attempting to make any particular reference.

The first seven chapters of Prof. Macalister's work are on general subjects: protoplasm, general morphology, histology, tectology (individuality and the formation of organs), reproduction, and the distribution of animals. There are certain statements in the last of these with which we cannot quite agree. That Patagonia should be entirely removed from the Neotropical Region and placed together with the Southern Circumpolar Land in a special Antarctic, seems very much at variance with known facts. Why the Polar Bear should be only mentioned in association with the Nearctic Circumpolar Region; the Aard-vark, Manis, and Manatee with the Guinean; the Catarrhine Monkeys with the Indian; Bennett's Cassowary with the Australian; the Birds of Paradise with the Indo-Malay, we are at a loss to comprehend.

In association with the doctrine of the origin of species we are told that, "as a natural deduction from evolution, we have *Dr. Haughton's* law, that all structures are arranged so as to give the maximum of work possible under the given external conditions." This law is, however, a natural deduction from the theory of natural selection, not from evolution; it not being evolution, *per se*, but the struggle for existence which brings to the foreground the most economical animal machinery. It may also be mentioned that there are still wanting some important links in the chain of reasoning which explains the diminution of organs, like the wings of birds, in small islands. These seem to be lost on account of the reduction of the struggle for existence, mammals not being on the ground to contest the field. Dr. Haughton's law, therefore, no longer applies apparently. Why then are the wings lost?

The classification adopted is that of Haeckel modified, the Metazoa being primarily divided into the two subseries, Polystomata (Sponges) and Monostomata; the Cœlenterata being removed from the Porifera, and included with the other forms in which there is but one aperture of ingress into the body-cavity. No very special stress is laid on the vertebrate affinities of the Tunicata, which are included in the sub-kingdom Vermes. Of their development we read that "in Ascidia and Phallusia the segmented yelk assumes its mulberry form, hollows within, and appears as a spherical, cellular body (blastula); a groove indents one side of this; the lips of the groove rise and close it in, except in one spot, and thus the body becomes bicavitary, the dorsal groove contracts, and the nerve ganglion develops either within it or in its close vicinity. On a plane between the dorsal neural cavity thus formed and the ventral space, a double row of large cells appears, which extends into the tail, and forms an axis for that organ. These cells resemble those of the chorda dorsalis of Vertebrates, and have a similar relation to the neural and visceral cavities of the primarily bicavitary body to that possessed by the dorsal chord. Upon these phenomena, observed by Kowalewsky, Kupffer, and others, is rested the theory of relationship of Tunicates and Vertebrates, which is strengthened by the setting apart here of a portion of the digestive canal for respiratory purposes." This quotation illustrates the condensed manner in which the whole work is written and the way in which single words are frequently modified to do the duty of whole sentences. As a second illustration of the same method when employed with reference to the sub-kingdom Cœlenterata, one in which name-coining has arrived at a worse pitch even than in systematic botany—the following sentence will suffice:—"The alternation of generations may be binary (hydranth, gonophore, + hydranth, gonophore, &c.), or ternary (hydranth, blastostyle, gonophore, + *h*, *b*, *g*, &c.), or quaternary (hydranth, blastostyle, blastocheme, gonocheme, + *h*, *b*, *b*, *g*, &c.); or even more complex if the hydranths be heteromorphic." The Mollusca are treated of between the Vermes and Arthropoda, it being remarked of them that "their structure can be easily understood by regarding them as Vermes with no articulated appendages, modified by unequal lateral development, and by a fusion of the metameres," although "we know as yet of no absolute passage forms or direct synthetic types." This being the case, we cannot understand how each of these major groups can be regarded as a sub-kingdom.

The author, in his preface, regrets that, owing to the long time that the work (written in 1873) has been going through the press, he has not been able to introduce into it references to recent discoveries, which explains several important omissions. Notwithstanding this, we are convinced that all zoologists will agree that the work is a most valuable addition to the literature of general animal morphology.

OUR BOOK SHELF

Introductory Text-book of Physical Geography. By David Page. Eighth Edition. (Blackwood and Sons, 1876.)

INTRODUCTORY text-books on Physical Geography are not numerous, and if we may judge by the calls for new editions, this one is growing in favour. It certainly gives in a short and handy form the most important facts of the subject—and in the descriptive part it is merely a question of the selection of the most important, and in this respect we think the selection judicious, as indeed it would appear to have been found. Dr. Page comes to Physical Geography from the side of Geology, and his readers reap the benefit of it, in the chapters relating to the structure of the earth, and to the work of rivers, and to the positions of mountain ranges, which are very good. In many other respects too, the book is worthy of the support it receives, the facts being told clearly, concisely, and for the most part truly.

We cannot help, however, drawing attention to one or two points which we think would at least have been differently worded if the author had approached his subject from a physical side in his explanation of phenomena. Thus we are told with reference to water, that "when converted into steam it occupies 1,696 times more space with a specific gravity of only ·622." The only standard of specific gravity mentioned is water at 62° F., and a physicist might ask at what *pressure* is the steam?

Again, we read, "the atmosphere being the medium

through which the sun's heat is conveyed to and from the earth, the lower and denser strata absorb the greatest amount, and are necessarily the warmer;" a sentence of which a teacher would score almost every word. Again, on the subject of dew, we read that "substances like glass, &c., which *rapidly* lose their own heat and *slowly* acquire that of others are susceptible of being copiously bedewed." The italics are ours. And once more, "when the temperature of the air is reduced below that of the invisible vapour it contains, the moisture becomes visible." These extracts could be multiplied till we might wonder if it is really a book on *Physical* Geography we are reading. But these are serious defects, and we wish they could be altered. By the side of them it is of less consequence that while we read in the Preface that "this revision embraces all that is important in recent discovery;" yet on turning to the temperature of the sea, where the most important changes have taken place in our knowledge, we are still referred to Sir James Clarke Ross, and told that the ocean has below the surface a uniform temperature of $39\frac{1}{2}°$, for which at the equator we must descend deeper than anywhere else. We can scarcely imagine that any amount of clearness will atone for these things; let us hope they will be seen to before edition the ninth is required.

The Flora of South Australia. By R. Schomburgk, Ph.D., Director of the Botanic Gardens, Adelaide. (W. C. Cox, 1875.)

WE have here a complete list of the indigenous flora of South Australia, both tropical and extra tropical, with some general remarks prefixed. The most predominant natural orders in the colony are Leguminosæ. Myrtaceæ, Compositæ, Proteaceæ, Cruciferæ, Rubiaceæ, and Gramineæ. The genera and species are remarkably circumscribed in area; many are found in one spot alone. The colony is singularly devoid of native edible fruits and roots; on the other hand it produces abundance of valuable timber-trees and of plants suitable for the manufacture of paper and other fibres, and for the production of dyes; but most of the valuable crops are naturalised plants, introduced from Europe or other parts of the world. A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Theory of Electrical Induction

IN NATURE, vol. xiii. pp. 437, 475, Prof. Paul Volpicelli gives an exposition of the two theories of electric induction, containing copious references to the writings of electricians, and numerous experiments of his own. It is remarkable, however, that he has not only omitted all reference to the works of Poisson, Green, Thomson, Beer, Betti, &c., who have studied the mathematical theory of induction, but he has not even introduced the word potential into his exposition, unless we are to take the word tension in the sense of potential, where he says that a certain portion of electricity possesses tension while another portion does not.

The result of this mode of treating the subject without calling in the aid of those ideas and phrases which the progress of science has developed, is to convey the impression that the whole theory of induction of electrification on the surface of conductors is still in a very imperfect and vague condition, whereas there is no part of electrical science in which we can trace more distinctly the correspondence, quantitative as well as qualitative, of the phenomena with the general laws of electricity. It appears, however, from what M. Volpicelli says, that an erroneous theory is still generally adopted in treatises on physics and electricity, and that it ought to be superseded by a more correct theory first proposed by Melloni.

Both theories admit that if an insulated conductor, without charge, is acted on by a charged inductor, the surface becomes electrified, oppositely to the charge of the inductor on the parts nearest the inductor, and similarly to the charge of the inductor on the parts farthest from it. The first of the two theories, however, asserts that both these electricities are "endowed with tension," whereas the second, that of Melloni, asserts that the electricity of the same kind with that of the inductor is alone "endowed with tension," while the other kind of electricity is entirely "latent or dissimulated."

The only sense which we can attach to the word "tension" as thus used, is that which modern writers mean by "potential," or potential function, the difference being that the word tension is often used in a vague manner, whereas potential is strictly defined.

Thus a point in space is said to have a certain electric potential, and since all points of a conductor in electrical equilibrium have the same potential, we speak of the potential of the conductor. But we do not speak of the potential of a charge of electricity, or of electricity being endowed or not endowed with potential. Such language would only lead us into error.

Let us suppose the inductor to be charged positively and the induced body to be insulated and originally without charge. Then, since its insulation prevents any electric communication with other bodies, its total electrification must remain zero, or there must be as much positive electrification as there is negative.

Hence for every line of electric force which proceeds from the inductor and falls on the induced body, there is another which proceeds from the induced body and falls on the walls of the room, or on some other body whose potential is zero. The potential of the induced body must therefore be intermediate between that of the inductor and that of the walls of the room, which is generally taken as zero. The potential of the induced body is therefore positive.

There is thus on the surface of the induced body a region nearer the inductor which is negatively electrified, and a region further from the inductor which is positively electrified. These regions are divided by a neutral line on the surface, which is the section of the surface by an equipotential surface in space which has the same potential as the induced body. The total charges on these two regions are exactly equal but of opposite signs.

If a small insulated conductor is placed in contact with any part of the surface and removed, it will be found to be electrified in the same way as the part of the surface with which it was in contact. A fine short needle point, or a burning pastille, placed on any part of the surface will dissipate the kind of electricity which exists on that part of the surface. See Riess, "Reibungs Elektricität," Art. 247.

If any part of the induced body is placed in electrical connection with the earth by touching it with a fine wire, positive electricity will be discharged, and the potential of the induced body will be reduced to zero. This will be the case whether the part touched be positively or negatively electrified. The quantity of electricity discharged will be the product of the potential of the induced body into its electric capacity.

After this discharge every part of the surface of the induced body will be negatively electrified, but the parts nearer the inductor more than those which are further from it.

In the mathematical treatment of the subject Thomson has found it convenient to divide the electrification into two parts, each distributed over the induced body according to its own law.

(α) The induced electrification when the induced body is connected to earth, and the charge of the inductor is E. This electrification is negative on every part of the surface, but the density is greatest next the inductor.

(β) The electrification when the induced body has a potential P, and the inductor, still in the same place, has no charge. This electrification is positive on every part of the surface.

From a knowledge of these two distributions it is easy to determine a third, in which the total electrification is the algebraical sum of (α) and (β), and in which the value of P is such that the total electrification is zero.

We might then assert that the electrification (β) is free, because it will be discharged if the body is connected to earth, but that the electrification (α) is latent or dissimulated, because it will not be discharged to earth.

The only danger of this mode of exposition is that it may suggest to a beginner the notion that electricity, like water and other substances, may exist in different physical states, in some of which it is more mobile than in others.

This idea of variation of quality once introduced into the

mind will tend to prevent the student from forming any clear and distinct conception of the phenomena.

Let us now examine how far M. Volpicelli's experimental skill and extensive reading have enabled him to give an accurate account of the phenomena, and how far he may have fallen into error from not availing himself of the idea of electric potential, but continuing to employ that of latent electricity.

Melloni, in his exposition has represented the homonymous electrification (β) as greater on the side of the induced body further from the inductor. The fact, however, is that the electrification is distributed in the same way as it would be if the inductor were in its actual position and insulated, but without charge. It will therefore be densest on the projecting parts of the induced body; but if the two extremities of this body are geometrically similar, and if the inductor is made of a conducting substance, it will be somewhat denser on the extremity (1) next the inductor, because the surface of the inductor itself (c) will become electrified and the electricity on the side next to B will be negative.

But the inequality of the distribution of the negative electrification (α) is so much greater that it completely masks that of (β), so that from an experimental point of view we must regard this error of Melloni as a very trifling one.

The next point we must notice is the mode in which objection (3) is expressed. It is as follows:—

"(3) Because of the two kinds of electricity which coexist upon the induced insulated body, only the homonym of the inductor is dissipated *by contact with the air*." (The italics are our own.)

We have no evidence whatever that electricity is ever dissipated by contact with air, whether dry or moist, unless the electric density is so great that a disruptive discharge takes place in the forms of "glow," "brush," or "spark," from some point connected with the electrified body.

If the electrified body and the surrounding conductor have rounded surfaces, and if the potential is moderate, it appears from the experiments of *Boltzmann*[1] that no measurable quantity of electricity passes through air or other gases, even when greatly rarefied, and when the experiment is continued for fourteen hours.

I have myself been unable to detect any conduction through a stratum of still air of two millimetres thickness, even when the temperature was raised to a red heat, and when steam or the vapour of mercury or of sodium was introduced between the oppositely electrified surfaces. If, however, any dust was introduced, there was a considerable effect arising from convection by the solid particles.

The cause of the powerful electrical effect of the stream of heated matter rising from a burning flame or from a red-hot ball, as in Guthrie's experiments, requires a special investigation.

The dissipation of the charge of insulated bodies which we actually observe seems to depend principally on the insulating supports on which they are placed, and if these are of good glass the conduction is almost entirely due to moisture on the surface of the glass. If the air which is in contact with the glass insulator is perfectly dry the dissipation of electricity will be extremely small even when the air in contact with the electrified body itself is loaded with moisture.

It is not, therefore, by contact with the air that the electricity escapes, but by conduction to the earth along the so-called insulating supports, and the effect of this conduction is of course to reduce the potential to zero by discharging electricity of the same kind with that of the inductor.

We come next to the fourth of the five facts mentioned under the head of the First Experiment. It is stated as follows:—

"4. Points applied to the extremity of the cylinder nearest to the inductor allow only the homonym of the inductor to escape, and not at all the opposite electricity."

This will be the case if the point is electrically connected with the earth, and made to approach any part of the surface of the cylinder; but if, as the words seem rather to imply, the point is attached to the cylinder and projects into the air, then the statement is exactly opposite to that given by Riess in Art. 247 of his book, who correctly tells us that if the cylinder has a sharp point at one end, then if the point is turned towards the inductor, the cylinder becomes charged similarly to the inductor, whereas if the point is turned away from the inductor, the cylinder becomes charged oppositely to the inductor, the discharge from the point being always of that kind of electricity which exists on the part of the cylinder where the point is placed.

The fifth fact stated to be established by the experiment is—

"5. Induced electricity of the first kind (opposite to that of the inductor) is not transferred from the induced body to the inductor, but the electricity of the inductor may certainly be transferred to the induced body."

For the sake of distinctness, let us say that the inductor is positive, then it is here asserted that negative electricity does not pass from the cylinder to the inductor, but that positive electricity passes from the inductor to the cylinder.

If M. Volpicelli can give us an experimental method of distinguishing between the passage of negative electricity from *B* to *A*, and the passage of positive electricity from *A* to *B*, we may expect to learn more of the nature of electricity than any of our physicists have hitherto even hoped for.

J. CLERK MAXWELL

[1] Sitzb. der k. Akad. (Wien) April, 1874.

Cherry Blossoms

IN the last number of NATURE (vol. xiv. p. 10), Mr. Pryor states that the flowers of the wild cherry are bitten off in large numbers in much the same manner as I formerly described in the case of the primrose. Some days ago I observed many cherry blossoms in this state, and to-day I saw some actually falling. I approached stealthily so as to discover what bird was at work, and behold it was a squirrel. There could be no doubt about it, for the squirrel was low in the tree and actually had a blossom between its teeth. It is none the less true that birds likewise bite the flowers of the cherry tree.

Down, Beckenham, May 6 CHARLES DARWIN

The Pollen of the Cherry

THE practice of the indefinite reproduction of woodcuts by means of *clichés* has frequently given rise to the repetition of erroneous drawings in one scientific text-book after another. Botanical text-books seem to have suffered especially in this way, in consequence of the great dearth of new and original illustrations by which they are characterised. Many botanical students must have been puzzled by the peculiar appearance presented by the pollen of the cherry in a very familiar drawing. It is hardly sufficiently explained that "the escape of the fovilla in an irregular jet," as there represented, has nothing to do with the process of fertilisation, but is an altogether abnormal phenomenon dependent on the bursting of the pollen-grain in [illegible] artificial moistening. The shape of the pollen-grain, as given, for example, in Balfour's "Class-book of Botany," Le Maout and Decaisne's "General System of Botany," and Dr. Hooker's Science Primer "Botany,"[1] is also incorrectly indicated. The perfectly spherical form represented in the drawing is almost, if not altogether, confined to anemophilous plants, fertilised by the wind. The cherry is, on the contrary, entomophilous, and its pollen partakes of the general character of this class of plants.

Though somewhat variable in size and form, the grains are, I believe, never spherical, but ellipsoidal, with three longitudinal furrows, as represented in the longitudinal and apical aspects, *a*, *b*, in the accompanying figure. The pollen has, however, well marked characters of its own, which distinguish it from that of allied plants, the ends often appearing truncated, as represented in *c*, and some or all of the grains more gibbous on one face than another (*d*). Most pollen grains assume a more spherical form on being moistened with water.

ALFRED W. BENNETT

[1] In Hooker's Primer there is the further complication of the accidental transposition of the figures of the cherry and evening primrose, the well-known triangular form of the latter being attributed to the former.

Spring Dynamometers

IN a former brief communication of mine on the subject of dynamometers (NATURE, vol. xiii. p. 385), suggested by an incidental remark made by Mr. Bottomley, I observed that "about three years ago Prof. Ball when introducing the C. G. S. system of units into the course of mechanics in this College had a series of dynamometers in absolute measure specially constructed for him." In reference to this statement, Dr. Ball's successor in the chair of mechanics, Prof. Hennessy, points out, in a letter to NATURE (vol. xiii., p. 466), that "the system actually employed is not that referred to by your correspondent; I generally employ the kilogram, metre, and second, and sometimes the foot, pound, and second, to measure a dynam or unit of force." It is, however, evident that the few words in my former letter did not question the merits of any particular system of units; whether the use of a mixed system of kilogram-metres and foot-pounds be an improvement upon a system now generally coming into use is a matter of opinion. And though the subject can hardly be one of much interest to your readers, I may, perhaps, remark that so far as my statement concerns Dr. Ball it is perfectly accurate; he was in the habit of using the C. G. S. system in his classes here, and I was unaware any change had been made in this respect, the following statement occurring in Prof. Hennessy's own syllabus for the present as well as last session:—"The unit of force employed is the 'dyne,' or that force which, acting uniformly upon one gramme for one second, will give it a velocity of one centimetre a second." Even if reference had been made to Prof Hennessy, one would naturally have concluded that the printed syllabus, authorised by the Department, was the one "actually employed."

Passing on to Dr. Ball's dynamometers, Prof. Hennessy remarks that "they cannot be depended upon to results within the tenth of a kilogramme"—finer readings when necessary could, no doubt, be taken by the eye, but that is really only a question for the maker, and the special purpose for which these instruments were designed: then follows the strong assertion that "spring dynamometers are totally unfit for measuring units on the C. G. S. system." As several instruments of precision depending on the tension of a spring recur to one's mind, instruments that only require proper precautions to yield extremely delicate and trustworthy results, it would be interesting to know upon what grounds Prof. Hennessy bases his emphatic and reiterated assertion. If it be merely a question of individual opinion, upon this subject hardly any authorities that could be quoted would carry such weight as Sir W. Thomson and Prof. P. G. Tait, who speak thus in their treatise on "Natural Philosophy," p. 127. "Spring balances we believe to be capable, if carefully constructed, of rivalling the ordinary balance in accuracy, while for some applications they far surpass it in sensibility and convenience."

Royal College of Science, Dublin W. F. BARRETT

The Meteors of April 20th

BETWEEN ten and twelve o'clock on the night of April 18th, Mr. W. L. Taylor, a member of the junior class in the State University, with several other gentlemen, observed an unusual number of shooting-stars. These gentlemen were returning in an open waggon from Ellettsville, eight miles north of Bloomington. No count was kept of the number of meteors observed, but the appearance was so frequent as to attract the attention of all the company. Mr. Taylor thinks the number noticed could not have been less than twelve or fifteen. From the descriptions given of the meteor tracks, I find that they were nearly conformable to the radiant of the Lyraids. The meteors were remarkably brilliant, apparently equal to stars of the first or second magnitude.

At my request Mr. Benjamin Vail, a student of the University, made observations on the nights of the 19th and 20th of April. Both nights were so cloudy, however, that a continuous watch would have been useless. About eleven o'clock on the night of the 19th, three meteors were seen in the north-west, where the sky at the time was partially clear.

Bloomington, Ind., April 26 DANIEL KIRKWOOD

American Mocking Bird

AN American mocking-bird, about a year old, which I had brought from Tennessee, has, for the past three or four weeks, been affected with an irritation round the eyes, causing the feathers to fall off and the flesh to swell; the bird is otherwise in a healthy condition, but has not sung since it has been affected with the soreness; it has the proper food supplied, and its cage is kept in a clean state; could any correspondent kindly inform me the cause and cure of the disease? M. C.

An Unusual Optical Phenomenon

THIS morning, a little after nine o'clock, the ordinary solar halo, radius about 22°, was seen. It was bright, and the red very distinct.

On turning to the north to find the direction of the cloud drift, a white band was seen extending to the north-east in one direction, and on to the west and south in the other. Its width was about that of the halo near the sun. A pair of compasses and a protractor gave the altitude of this circle about 45°. This being about the sun's altitude, the plane of the circle was no doubt parallel to the horizon and passed through the sun. I believe the circle above described to be but rarely seen.

JOSEPH GLEDHILL

Mr. Crossley's Observatory, Halifax, May 3

OUR ASTRONOMICAL COLUMN

THE BINARY λ OPHIUCHI.—An examination of the recent measures of this star, shows that neither of the orbits computed some 25 or more years since by Madler and Hind at all represents the later course of the companion, a circumstance mainly attributable, as it appears, to error in one, if not in both, of Sir W. Herschel's measures. Struve at first considered that the angle of 1783 required a correction of 180°, but at a later period he was inclined to apply a similar correction to the angle of 1802, and Dawes also believed it was the latter measure which required alteration, in order to render any orbit possible. It is upon this supposition that the orbits of Madler and Hind have been calculated: the two sets of elements are subjoined:—

	Madler	Hind.
Peri-astron passage	1790·31	1791·21
Period of revolution in years	89·01	95·88
Node	32° 42′	30° 23′
Angle between the lines of nodes and apsides on orbit	120° 4′	135° 24′
Inclination	49° 25′	49° 40′
Excentricity	0·4530	0·4772
Semi-axis major	0″·842	0″·847

Madler's orbit was published in "Untersuchungen uber die Fixsterne-Systeme, Erster Theil." The second orbit was founded upon observations to about the same year, 1849. The projection of the measures since this epoch, however, makes it apparent that the real orbit must be materially different from the above, and the star may be recommended to the attention of those who are interested in the determination of elements of the revolving double-stars.

Sir W. Herschel's papers containing his measures of double stars communicated to the Royal Society, not being always of easy access, the following extracts from his notes on λ Ophiuchi may perhaps prove useful:—

From the *Phil. Trans.*, vol. lxxv., p. 62:—

"I. 83; 1783, March 9. A very beautiful and close double-star, L. w.; S. blue; both fine colours. Considerably or almost very unequal. With 460, $\frac{1}{4}$ or $\frac{1}{3}$ diameter of S.; with 932 full $\frac{1}{3}$ diameter of S. Position 14° 30′ n. following."

From the memoir of 1804:—

"May 20, 1802, position was 20° 41′. The position March 9, 1783, was 14° 30′, north following. The difference in nineteen years and seventy-two days is 6° 11′. May 1 and 2, 1802, I could not perceive the small star, though the last of the two evenings was very fine. May 20, 1802, with 527, I saw it very well, but with great difficulty. The object is uncommonly beautiful, but it requires a most excellent telescope to see it well and the focus ought to

be adjusted upon ϵ of the same constellation, so as to make that perfectly round."

These remarks have an essential bearing upon the investigation of elements. The components must have been very close at both Herschel's epochs—if there be no mistake in the register—and this is not at first sight readily explained by the curve exhibiting the motion of the smaller star from Struve's earliest micrometrical measures in 1825 to the present date.

Herschel further remarked in 1802 that the appearance of the components was much like that of "a planet with a large satellite, or small companion," and strongly suggestive of "the idea of a connection between the two bodies, especially as they are much insulated."

THE ROTATION OF VENUS.—In a note upon the time of rotation and position of the axis of Venus, which recently appeared in this column, reference was inadvertently omitted to Flaugergues' observations at Viviers in July, 1796, which, according to a communication from Valz to the *Astronomische Nachrichten* (No. 278, vol. xi), seemed to favour Bianchini's period, and placed the north pole of Venus in longitude 321° 20′, with an elevation of 16° 28′. Details of the observations are wanting, but Valz states that Flaugergues observed with "une ancienne lunette à deux verres de 18 pieds de long, amplifiant 105 fois qu'il dit fort bonne." He also employed one of 14 feet, and a telescope said to be good, which Legentil brought from India. Valz adds: "J'ai vu le dessein original de la tache, elle était grande et de forme trapezoide arrondie, &c."

Hussey's vigorous but prejudiced defence of the extraordinary period of rotation assigned by Bianchini will be found in *Astronomische Nachrichten*, No 248.

Fritsch, of Quedlinburg, thought some observations of his in April 1801 indicated a period of 23h. 22m. (*Berliner Astronomisches Jahrbuch*, 1804, p. 213).

SONG OF THE SCREW

A MOVING form or rigid mass,
  Under whate'er conditions,
Along successive screws must pass
  Between each two positions.
It *turns around* and *slides along*—
This is the burden of my song.

The *pitch of screw*, if multiplied
  By angle of rotation,
Will give the distance it must glide
  In motion of translation.
Infinite pitch means pure translation,
And zero pitch means pure rotation.

Two motions on two given screws,
  With amplitudes at pleasure,
Into a third screw-motion fuse;
  Whose amplitude we measure
By parallelogram construction
(A very obvious deduction).

Its axis cuts the nodal line
  Which to both screws is normal,
And generates a form divine,
  Whose name, in language formal,
Is "surface-ruled of third degree."
Cylindroid is the name for me.

Rotation round a given line
  Is like a *force* along.
If to say *couple* you incline,
  You're clearly in the wrong;—
'Tis obvious, upon reflection,
A line is not a mere direction.

So *couples* with *translations* too
  In all respects agree;
And thus there centres in the screw
  A wondrous harmony
Of Kinematics and of Statics,—
The sweetest thing in mathematics.

The forces on one given screw,
  With motion on a second,
In general some work will do,
  Whose magnitude is reckoned
By angle, force, and what we call
The *coefficient virtual*.

Rotation now to force convert,
  And force into rotation;
Unchanged the work, we can assert,
  In spite of transformation.
And if two screws no work can claim,
Reciprocal will be their name.

Five numbers will a screw define,
  A screwing motion, six;
For four will give the axial line,
  One more the pitch will fix;
And hence we always can contrive
One screw reciprocal to five.

Screws—two, three, four, or five, combined
  (No question here of sex),
Yield other screws which are confined
  Within one *screw complex*.
Thus we obtain the clearest notion
Of *freedom* and *constraint* of motion.

In complex III. three several screws
  At every point you find,
Or if you one direction choose,
  One screw is to your mind;
And complexes of order III.
Their own reciprocals may be.

In IV., wherever you arrive,
  You find of screws a cone.
On every line in complex V.
  There is precisely one;
At each point of this complex rich,
A plane of screws have given pitch.

But time would fail me to discourse
  Of Order and Degree,
Of Impulse, Energy, and Force,
  And Reciprocity.
All these and more, for motions small,
Have been discussed by Dr. Ball.

ON THE TELEPHONE, AN INSTRUMENT FOR TRANSMITTING MUSICAL NOTES BY MEANS OF ELECTRICITY

MR. ELISHA GRAY recently read a paper before an American Society explaining his apparatus for experimentally how, by means of a current of electricity in a single wire, a number of notes could be reproduced simultaneously at a great distance, and how by this means also a number of telegraphic messages could be transmitted at once along a wire and separately received at the other end. One of Mr. Gray's apparatuses was exhibited in London at the last *soirée* of the Society of Telegraph Engineers by the president, Mr. Latimer Clark. The principle of the apparatus is as follows:—

A vibrating reed is caused to interrupt the electric current entering the wire a certain number of times per second and the current so interrupted at the sending end sets a similar reed vibrating at the distant end.

The sending reed is ingeniously maintained in constant vibration by a pair of intermittent electro-magnets which are magnetised and demagnetised by the vibrating reed itself.

Thus in Fig. 1 (which represents the transmitting part of the telephone and its connections for a single note), the current from the magnet battery flowing in the direction of the small arrow passes through the pair of electro-magnets A to the terminal r of the reed R, and thence by the spring contact b and the wire bZ to the battery again, completing its circuit without passing through the other pair of electro-magnets B, which are not therefore magnetised. The reed R is consequently pulled over by the electro-magnets A. But on this taking place the spring contact b is broken and the circuit is no longer completed through bZ but through the electro-magnets B, which are consequently magnetised, and tend by their induction on the reed to neutralise that of B. The reed

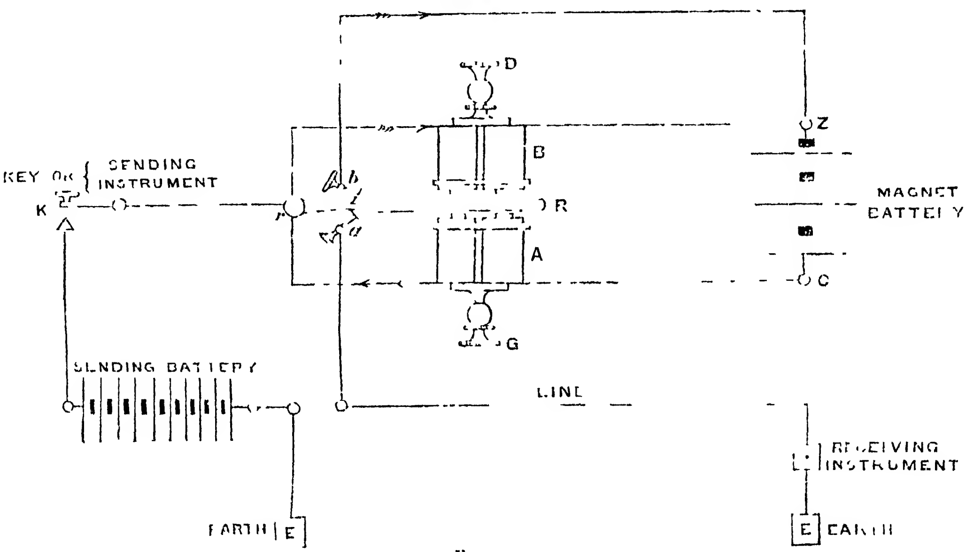


Fig. 1.

therefore springs back to its intermediary position, but in doing the contact at b is again made and the electro-magnets B again short-circuited and the reed pulled over (or rather *assisted* over, for it has its own resilience or spring) towards A; so this goes on keeping the reed in vibration between the electro-magnets and alternately making and breaking the spring contact b and also that of a, the number of contacts per second being dependant on the vibrating period of the reed.

While this is going on the reed of course emits its musical note. Two Leclanché or bichromate cells are sufficient to work the transmitter and give a good note.

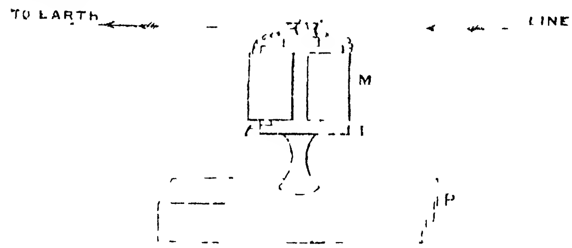


Fig. 2.

The spring contact b is to be adjusted by the screw there seen until the note emitted by the reed is both loud and pure. The magnets A and B are adjustable to or from the reed by the milled heads C and D.

The spring contact a just mentioned belongs properly to the line circuit. It is the intermittent contact which interrupts the current sent into the line. As will be seen from the diagram the circuit of the sending battery is made through the key K, the reed, and the spring contact a. On holding down the key K the current flows into the line, being interrupted, however, by the contact a as many times per second as the reed vibrates, and this intermittent current flowing to earth at the distant station, is made to elicit a corresponding note from the receiving apparatus there.

The receiving instruments are of two kinds, electro-magnetic and physiological.

In the first there is a plain double electro-magnet with a steel tongue having one end rigidly fixed to one pole, the other end being free to vibrate under the other pole. This stands over a wooden pipe closed at one end. Thus in Fig. 2 t T is the steel tongue fixed at t and free at

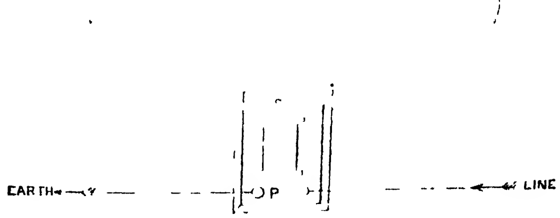


Fig. 3.

T, while P is the sounding-pipe. The received current, coming from the line and passing through the electro-magnet M to earth, sets the tongue vibrating, and the pipe gives forth the same note as the reed at the sending station. Ten Daniell cells working through 1,000 ohms, give a good strong note, especially when the receiver is

held in the hand close to the head. The screw *a*, Fig. 1, must be adjusted to give the best effect.

The other receiving instrument is the most interesting of the two. It consists of a small induction coil used in conjunction with a peculiar sounding-box, as shown in Fig. 3.

Here the line-current is passed to earth through the primary circuit P of the small induction coil, and the induced current is led to the sounding-box. This consists of a flat hollow cylindrical wooden box B, covered by a convoluted face of sheet zinc with two air holes *hh*, perforated in it, this box is attached to a metal axle A, turning in forked iron bearings, insulated from but supported by an iron stand S. By this means the sounding-box can be revolved by the ebony handle E. The zinc face is connected across the empty interior of the box by a wire W to the metal bearings on the other side. One end of the secondary circuit of the induction coil is to be connected to the metal bearing by the terminal *a*, and the other to a short bare wire held in the left hand. On then striking a finger of the hand holding the wire smartly across the zinc face, the proper note is sounded by the box; or, what is more convenient, on turning the box by the insulated handle and keeping the point of the finger rubbing on its face, the note is heard. The rough under side of the finger pressed pretty hard on the bulging part of the face is best. The instant the current is put on by the sending key K, Fig. 1, the dry rasp of the skin on the zinc-surface becomes changed into a musical note.

These "sounders" can be made to receive indifferently a variety of notes. I have under my care at present a telephone with four transmitters tuned to give the four notes of the common chord, and two receivers, which interpret equally well any one of these notes or all together. But sounders are also made in the same way which will emit only one special note, and so are sensible only to the corresponding current. It is by their means that the telephone can be applied to multiplex telegraphy. As many as eight transmitters may be set to interrupt the line current according to the vibrations of eight different tuning-forks, and the resultant current can be made by means of eight special receivers to reproduce the same number of corresponding notes at the distant station. The current is controlled by eight keys at the sending end and sifted by eight sounders at the receiving end, each sounder being sensitive only to those portions of the current affected by its corresponding transmitter. The superimposed effect of the eight keys and transmitters on the line current can all be separately interpreted at the receiving end. Thus eight messages might be transmitted simultaneously along one wire in the same direction. It would seem hitherto, however, that this method of telegraphy by the telephone is inferior to the ordinary methods in point of speed of signalling, and in the length of circuit which can be worked by a given battery power.

J. MUNRO

OUR PERCEPTION OF THE DIRECTION OF A SOURCE OF SOUND[1]

THE practical facility with which we recognise the situation of a sounding body has always been rather a theoretical difficulty. In the case of sight a special optical apparatus is provided whose function it is to modify the uniform excitation of the retina, which a luminous point, wherever situated, would otherwise produce. The mode of action of the crystalline lens of the eye is well understood, and the use of a lens is precisely the device that would at once occur to the mind of an optician ignorant of physiology. The bundle of rays, which would otherwise distribute themselves over the entire retina, and so give no indication of their origin, are made to converge upon a single point, whose excitation is to us the sign of an external object in a certain definite direction. If the luminous object is moved, the fact is at once recognised by the change in the point of excitation.

There is nothing in the ear corresponding to the crystalline lens of the eye, and this not accidentally, so to speak, but by the very nature of the case. The efficient action of a lens depends upon its diameter being at least many times greater than the wave-length of light, and for the purposes of sight there is no difficulty in satisfying this requirement. The wave-length of the rays by which we see is not much more than a ten-thousandth part of the diameter of the pupil of the eye. But when we pass to the case of sound and the ear the relative magnitudes of the corresponding quantities are altogether different. The waves of sound issuing from a man's mouth are about eight feet long, whereas the diameter of the passage of the ear is quite small, and could not well have been made a large multiple of eight feet. It is evident therefore that it is useless to look for anything corresponding to the crystalline lens of the eye, and that our power of telling the origin of a sound must be explained in some different way.

It has long been conjectured that the explanation turns upon the combined use of both ears; though but little seems to have been done hitherto in the way of bringing this view to the test. The observations and calculations now brought forward are very incomplete, but may perhaps help to clear the ground, and will have served their purpose if they induce others to pursue the subject.

The first experiments were made with the view of finding out with what degree of accuracy the direction of a sound could be determined, and for this it was necessary of course that the observer should have no other material for his judgment than that contemplated.

The observer, stationed with his eyes closed in the middle of a lawn on a still evening, was asked to point with the hand in the direction of voices addressed to him by five or six assistants, who continually shifted their position. It was necessary to have several assistants, since it was found that otherwise their steps could be easily followed. The uniform result was that the direction of a human voice used in anything like a natural manner could be told with certainty from a single word, or even vowel to within a few degrees.

But with other sounds the result was different. If the source was on the right or the left of the observer, its position could be told approximately, but it was uncertain whether, for example, a low whistle was in front or behind. This result led us to try a simple sound, such as that given by a fork mounted on a resonance box. It was soon found that whatever might be the case with a truly simple sound, the observer never failed to detect the situation of the fork by the noises accompanying its excitation, whether this was done by striking or by a violin bow. It was therefore necessary to arrange the experiment differently. Two assistants at equal distances and in opposite directions were provided with similar forks and resonators. At a signal given by a fourth, *both* forks were struck, but only *one* was held over its resonator, and the observer was asked to say, without moving his head, which he heard. When the observer was so turned that one fork was immediately in front and the other immediately behind, it was impossible for him to tell which fork was sounding, and if asked to say one or the other, felt that he was only guessing. But on turning a quarter round, so as to have one fork on his right and the other on his left, he could tell without fail, and with full confidence in being correct.

The possibility of distinguishing a voice in front from a voice behind would thus appear to depend on the compound character of the sound in a way that it is not easy to understand, and for which the second ear would be of no advantage. But even in the case of a lateral sound

[1] Abstract of a Communication to the Musical Association, by Lord Rayleigh, F.R.S.

[the] matter is not free from difficulty, for the difference of [int]ensity with which a lateral sound is perceived by the two [ea]rs is not great. The experiment may easily be tried [ro]ughly by stopping one ear with the hand, and turning [ro]und backwards and forwards while listening to a sound [he]ld steadily. Calculation shows, moreover, that the [hu]man head, considered as an obstacle to the waves of [so]und, is scarcely big enough in relation to the wave-[le]ngth to give a sensible shadow. To throw light on this [su]bject I have calculated the intensity of sound due to a [d]istant source at the various points on the surface of a [fi]xed spherical obstacle. The result depends on the ratio [(a]) between the circumference of the sphere and the [l]ength of the wave. If we call the point on the spherical surface nearest to the source the anterior pole, and the opposite point (where the shadow might be expected to be most intense) the posterior pole, the results on three suppositions as to the relative magnitudes of the sphere and wave-length are given in the following table:—

			Intensity.
a	2	Anterior pole	·690
		Posterior pole	·318
		Equator	·356
a	1	Anterior pole	·503
		Posterior pole	·285
		Equator	·237
a	½	Anterior pole . .	·294
		Posterior pole .	·260
		Equator .. .	·232

When, for example, the circumference of the sphere is but half the wave-length, the intensity at the posterior pole is only about a tenth part less than at the anterior pole, while the intensity is least of all in a lateral direction. When a is less than ½, the difference of the intensities at the two poles is still less important, amounting to about one per cent. when $a = \frac{1}{4}$.

The value of a depends on the wave-length, which may vary within pretty wide limits, and it might be expected that the facility of distinguishing a lateral sound would diminish when the sound is grave. Experiments were accordingly tried with forks of a frequency of 128, but no greater difficulty was experienced than with forks of a frequency of 256, except such as might be attributed to the inferior loudness of the former. According to calculation the difference of intensity would here be too small to account for the power of discrimination.

PROF. HUXLEY'S LECTURES ON THE EVIDENCE AS TO THE ORIGIN OF EXISTING VERTEBRATE ANIMALS[1]

VI.

IN the highest group of Vertebrates, the Mammalia, the perfection of animal structure is attained. It will hardly be necessary, indeed it will be impossible, in the time at our disposal, to give the general characters of the group, but our purpose will be answered as well by devoting a short time to considering the peculiarities of a single well-known animal, the evidence as to the origin of which approaches precision.

The horse is one of the most specialised and peculiar of animals, its whole structure being so modified as to make it the most perfect living locomotive engine which it is possible to imagine. The chief points in which its structure is modified to bring about this specialisation, and in which, therefore, it differs most markedly from other mammals, we must now consider.

In the skull the orbit is completely closed behind by bone, a character found only in the most modified mammals. The teeth have a very peculiar character. There are, first of all, in the front part of each jaw, six long curved incisors or cutting teeth, which present a singular dark mark on their biting surfaces, caused by the filling in of a deep groove on the crown of each tooth, by the substances on which the animal feeds. After the incisors, comes on both sides of each jaw a considerable toothless interval, or *diastema*, and then six large grinding teeth, or molars and pr[e]molars. In the young horse a small extra premolar is found to exist at the hinder end of the diastema, so that there are, in reality, seven grinders on each side above and below; furthermore, the male horse has a tusk-like tooth, or canine, in the front part of the diastema immediately following the last incisor. Thus, the horse has, on each side of each jaw, three incisors, one canine, and seven grinders, making a total of forty-four teeth.

The grinding surfaces of the molars and premolars are very curious. In the upper jaw, each tooth is marked by four crescentic elevations, concave externally, the inner pair having each a curious folded mass connected with it. These projecting marks are formed of dentine and enamel, and, consequently, wear away more slowly than the intervening portions of the tooth, which are composed of cement. The lower grinders are marked with two crescents and two accessory masses, but the crescents are convex externally, and, consequently, when the opposite teeth bite together, the elevations do not correspond at any point. In this way a very perfect grinding surface is obtained. The teeth are of great length, and go on growing for a long time, only forming roots in old animals. All these points contribute to the perfection of the horse as a machine, by rendering the mastication of the food, and its consequent prepara[t]ion for digestion in the stomach, as rapid and complete a process as possible.

It is, however, in the limbs that the most striking deviation from the typical mammalian structure is seen, the most singular modifications having taken place to produce a set of long, jointed levers, combining great strength with the utmost possible spring and lightness.

The humerus is a comparatively short bone inclined backwards: the radius is stout and strong, but the ulna seems to be reduced to its upper end—the olecranon or elbow; as a matter of fact, however, its distal end is left, fused to the radius, but the middle part has entirely disappeared: the carpus or wrist—the so-called "knee" of the horse—is followed by a long "cannon bone," attached to the sides of which are two small "splint bones": the three together evidently represent the metacarpus, and it can be readily shown that the great cannon-bone is the metacarpal of the third finger, the splint-bones those of the second and fourth. The splint-bones taper away at their lower ends and have no phalanges attached to them, but the cannon-bone is followed by the usual three phalanges, the last of which, the "coffin-bone," is ensheathed by the great nail or hoof.

The femur, like the humerus, is a short bone, but is directed forwards; the tibia turns backwards, and has the upper end of the rudimentary fibula attached to its outer angle. The latter bone, like the ulna, has disappeared altogether as to its middle portion, and its distal end is firmly united to the tibia. The foot has the same structure as the corresponding part in the fore limb: a great cannon-bone, the third metatarsal; two splints, the second and fourth: and the three phalanges of the third digit, the last of which bears a hoof.

Thus, in both fore and hind limb one toe is selected, becomes greatly modified and enlarged at the expense of the others, and forms a great lever, which, in combination with the levers constituted by the upper and middle divisions of the limb, forms a sort of double C-spring arrangement, and thus gives to the horse its wonderful galloping power.

In the river-beds of the Quaternary age—a time when England formed part of the Continent of Europe—

[1] A course of six lectures to working men, delivered in the theatre of the Royal School of Mines. Lecture VI., April 3. Continued from vol. xiii. p. 516.

abundant remains of horses are found, which horses resembled altogether our own species, or perhaps are still more nearly allied to the wild ass. The same is the case in America, where the species was very abundant in the Quaternary epoch—a curious fact, as, when first discovered by Europeans, there was not a horse from one end of the vast continent to the other.

In the Pliocene and older Miocene, both of Europe and America, are found a number of horse-like animals, resembling the existing horse in the pattern and number of the teeth, but differing in other particulars, especially the structure of the limbs. They belong to the genera *Protohippus*, *Hipparion*, &c., and are the immediate predecessors of the Quaternary horses.

In these animals the bones of the fore-arm are essentially like those of the horse, but the ulna is stouter and larger, can be traced from one end to the other, and, although firmly united to the radius, was not ankylosed with it. The same is true, though to a less marked extent, of the fibula.

But the most curious change is to be found in the toes. The third toe though still by far the largest, is proportionally smaller than in the horse, and each of the splint bones bears its own proper number of phalanges; a pair of "dew-claws," like those of the reindeer, being thus formed, one on either side of the great central toe. These accessory toes, however, by no means reached the ground, and could have been of no possible use, except in progression through marshes.

The teeth are quite like those of the existing horse, as to pattern, number, presence of cement, &c.; the orbit also is complete, but there is a curious depression on the face-bones, just beneath the orbit, a rudiment of which is, however, found in some of the older horses.

On passing to the older Miocene, we find an animal, known as *Anchitherium*, which bears, in many respects, a close resemblance to Hipparion, but is shorter-legged, stouter-bodied, and altogether more awkward in appearance. Its skull exhibits the depression mentioned as existing in Hipparion, but the orbit is incomplete behind, thus deviating from the specialised structure found in the horse, and approaching nearer to an ordinary typical mammal. The same is the case with the teeth, which are short and formed roots at an early period; their pattern also is simplified, although all the essential features are still retained. The valleys between the various ridges are not filled up with cement, and the little anterior premolar of the horse has become as large as the other grinders, so that the whole forty-four teeth of the typical mammalian dentition are well developed. The diastema is still present between the canines and the anterior grinding teeth—a curious fact in relation to the theory that the corresponding space in the horse was specially constructed for the insertion of the bit; for, if the Miocene men were in the habit of riding the Anchitherium, they were probably able to hold on so well with their hind legs as to be in no need of a bit.

The fibula is a complete bone, though still ankylosed below to the tibia; the ulna also is far stouter and more distinct than in Hipparion. In both fore and hind foot the middle toe is smaller, in relation to the size of the animal, than in either the horse or the Hipparion, and the second and fourth toes, though still smaller than the third, are so large that they must have reached the ground in walking. Thus, it is only necessary for the second and fourth toes, and the ulna and fibula to get smaller and smaller for the limb of Anchitherium to be converted into that of Hipparion, and this again into that of the horse.

Up to the year 1870 this was all the evidence we had about the matter, except for the fact that a species of *Palæotherium* from the older Eocene was, in many respects, so horse-like, having, however, well-developed ulna and fibula, and the second and fourth toes larger than in Anchitherium, that it had every appearance of being the original stock of the horse. But within the last six years some remarkable discoveries in central and western North America, have brought to light forms which are, probably, nearer the direct line of descent than any we have hitherto known.

In the Eocene rocks of these localities, a horse-like animal has been found, with three toes, like those of Anchitherium, but having, in addition, a little style of bone on the outer side of the fore foot, evidently representing the fifth digit. This is the little *Orohippus*, the lowest member of the Equine series.

This evidence is conclusive as far as the fact of evolution is concerned, for it is preposterous to assume that each member of this perfect series of forms has been specially created; and if it can be proved—as the facts adduced above certainly do prove—that a complicated animal like the horse may have arisen by gradual modification of a lower and less specialised form, there is surely no reason to think that other animals have arisen in a different way.

This case, moreover, is not isolated. Every new investigation into the Tertiary mammalian fauna brings fresh evidence, tending to show how the rhinoceros, the pigs, the ruminants, have come about. Similar light is being thrown on the origin of the carnivora, and also, in a less degree, on that of all the other groups of mammals.

It may well be asked why such clear evidence should be obtainable as to the origin of mammals, while in the case of many other groups—fish, for instance—all the evidence seems to point the other way. This question cannot be satisfactorily answered at present, but the fact is probably connected with the great uniformity of the conditions to which the lower animals are exposed, for it is invariably the case that the higher the position of any given animal in the scale of being, the more complex are the conditions acting on it.

It is not, however, to be expected that there should be, as yet, an answer to every difficulty, for we are only just beginning the study of biological facts from the evolutionary point of view. Still, when we look back twenty years to the publication of the "Origin of Species," we are filled with astonishment at the progress of our knowledge, and especially at the immense strides it has made in the region of palæontological research. The accurate information obtained in this department of science has put the *fact* of evolution beyond a doubt; formerly, the great reproach to the theory was, that no support was lent to it by the geological history of living things; now whatever happens, the fact remains that the hypothesis is founded on the firm basis of palæontological evidence.

THE LOAN COLLECTION CONFERENCES

CONSIDERABLE progress has been made in the arrangements for holding conferences in connection with the approaching Loan Collection of Scientific Apparatus at South Kensington.

In the Section of Mechanics, which includes Pure and Applied Mathematics and Measurement, the conferences will be held on May 17, 22, and 2[illegible], and the following gentlemen have promised to give addresses or to take part:—

Dr. Siemens, F.R.S., general address with special reference to Measurement.

Mr. F. J. Bramwell, F.R.S., on Prime Movers.

Mr. Barnaby, Director of Naval Construction to the Admiralty.—Naval Architecture.

Mr. W. Froude, M.A., F.R.S.—Fluid Resistance.

M. Tresca, Sous-Directeur du Conservatoire des Arts et Métiers, Paris.—Flow of Solids.

M. le General Morin, Directeur du Conservatoire des Arts et Métiers, Paris.—Ventilation of Public Buildings.

Sir Joseph Whitworth, Bart., F.R.S.—Linear Measure-

Prof. Goodeve, M.A.—Solid Measurement.
Prof. Kennedy, C.E.—Kinematics.
Mr. W. Hackney.—Furnaces.
Prof. Sir W. Thomson, LL.D., F.R.S.—Electrical Measurement.
Mr. Westmacott.—Hydraulic Transmission.
Prof. Tilser (Bohemian Polytechnic Institute, Prague).—His new Method of Descriptive Geometry.

In the Section of Physics (including Astronomy), the following arrangements have been made provisionally:—

May 16.—Address by the President, Mr. Spottiswoode; Mr. Norman Lockyer, Capt. Abney, and Mr. Huggins—Spectroscopy; Prof. Clifton—Interference; Professors Adams and Stokes, and Mr. Spottiswoode—Polarisation; Mr. Sorby, or Dr. Royston Pigott—Microscopes; M. Becquerel and Prof. Stokes—Fluorescence; Sir W. Thomson—Electrometers.

May 19.—Prof. Tyndall—Reflection of Sound; Prof. Adams—Wheatstone's Researches; Prof. Guthrie—Heat; Mr. De la Rue—Astronomical Photography; and M. Leverrier.

May 24. Prof. Clerk-Maxwell, Prof. Andrews, and M. Tresca—Molecular Construction of Matter; Mr. De la Rue—Electric Batteries; Prof. Carey Foster—Galvanometers; Baron Ferdinand von Wrangel—Voltameters; M. Viandel—Gramme's Machine; and M. Helmholtz.

The conferences in Chemistry will be held on the 18th and 23rd May, and the following communications have been promised:—

Address by the Chairman, Dr. Frankland, F.R.S., generally on the objects exhibited in this section, and specially on the instruments used for the investigation of gases.

Dr. J. H. Gilbert, F.R.S., on some points in connection with vegetation.

Mr. Donkin, Demonstrator of Chemistry in the Oxford Museum, on Sir B. Brodie's apparatus used in the investigation of ozone.

M. Fremy, Membre de l'Institut de France, on the preservation of animal food.

Prof. Roscoe, F.R.S., on Vanadium and its compounds.

Prof. Guthrie, F.R.S., on Cryohydrates.

The conferences in Biology will be held on May 26 and 29, and will relate chiefly to the following subjects, viz.:—

(1) The methods of measurement and registration which are applicable to the vital phenomena of plants, animals, and man; (2) the methods and instruments employed in physiological optics and acoustics; and (3) the modes of preparing the tissues of plants and animals for microscopical examination. Explanations of apparatus and instruments will be given by the President, Professors Donders, Hering, Marey, Crum Brown, M. Foster, Flower, M'Kendrick, Thiselton Dyer, Messrs. Liebreich, Pritchard, Mosso, Gaskell, and others.

The Conferences in Physical Geography, Geology, Mineralogy, and Meteorology will be held on May 30, and June 1 and 2, and the following gentlemen have promised to take part:—

Mr. John Evans, F.R.S., general address on the objects exhibited in the section. In Meteorology, Prof. Roscoe, Mr. T. Stevenson, Mr. R. H. Scott, Mr. G. J. Symons, Dr. Mann, and Mr. Galloway. In Geography, Major Anderson, Lieut. Cameron, Mr. Clements Markham, Col. Walker, Professeur Forel, Prof. Wyville Thomson, and Mr. Francis Galton. In Geology and Mining, M. Daubrée, Prof. Ramsay, Mr. Rance, Baron Von Ettinghausen, and Mr. Topley. In Mineralogy, &c., M. des Cloiseaux, and the Rev. N. Brady.

NOTES

The Eighth Annual Report of the Geological and Geographical Survey of the Territories, under the direction of Prof. F. V. Hayden, has just been issued from the U.S. Government Printing Office. It is a report of progress of the explorations, mainly in Colorado, for the year 1874, and contains twelve articles in 500 octavo pages, and eighty-eight illustrations, including maps and sections. It commences with an introductory letter to the Secretary of the Interior, under whose auspices the survey is conducted, which contains a general account of the organisation of the various field divisions, and the progress of the work. Following this is the part devoted to geology, mineralogy, and mining industry, containing the reports of Prof. Hayden, Wm. H. Holmes, Dr. A. C. Peale, Dr. F. M. Endlich, and Samuel Aughey, Ph.D. Dr. Hayden's report is devoted to the special geology of the eastern part of the Rocky Mountains in Colorado, the Arkansas Valley, and portions of the Elk Mountains. The report of Wm. H. Holmes is devoted to the geology of the north-western portion of the Elk Mountains. The report of Dr. A. C. Peale gives the general and special features of the district assigned to the middle division of the survey, viz., the country lying between the Grand and Gunnison rivers west of the 107th meridian. Dr. F. M. Endlich reports on the San Juan country, giving chapters on the metamorphic, volcanic, and sedimentary areas and mines of the region. All these reports are abundantly illustrated with woodcuts, sections, and geological maps. Dr. Samuel Aughey has an interesting and practical report on the superficial deposits in Nebraska. The second paper is devoted to palæontology, and contains papers on the flora of the lignitic formations of North America, by Mr. Leo Lesquereux. A large number of new fossil plants are described and illustrated in eight plates. Following the palæontology is the report of Mr. W. H. Jackson on the ancient ruins of South-western Colorado. Eight plates of the cliff-houses, cave-dwellings, and other ruins of the Mancos, McElmo, and Hovenweep rivers accompany the report. Following Mr. Jackson's interesting report is an article on the zoological work for 1874. It contains descriptions and figures of several new species in conchology. The last division of the volume comprises the portion devoted to topography and geography, containing the following reports:—Mr. Henry Gannett's on the middle district, Mr. S. B. Ladd's on the northern district, and Mr. A. D. Wilson's and Franklin Rhoda's on the San Juan or southern district. These reports give the general topographical features of the areas surveyed, the means of communication and elevations of principal points. A complete table of contents and exhaustive indexes accompany the report. There is a general index of systematic names.

Orders have been given by the French Minister of Public Works for entering into a contract for the construction of the large refractor, whose length will be seventeen metres. A sum of 210,000 francs is to be paid to M. Eichens when the work is completed. The huge instrument is to be delivered two years hence. It will not be placed under a movable shade like the great reflector, but a cupola of requisite dimensions is to be constructed. All these arrangements have already been devised by M. Leverrier.

In a lecture on the Geographical Distribution of Birds, the first of a course delivered by Mr. R. B. Sharpe, on the 2nd inst., at the St. John's Wood Assembly Rooms, the lecturer exhibited, by the oxycalcium light, a large series of maps of the world, about fifty in number, each coloured in that part only where the bird he was speaking of is distributed. A carefully-painted slide of the bird, from the pencil of Mr. Keulemans, was also introduced with the description of the plumage of each species, and in association with the map of its distribution.

A plague of Field Voles (*Arvonicola agrestis*) has recently visited some of the pastoral farms of Upper Teviotdale and the adjoining districts, which has led to the appointment of a committee of the Farmers' Club of the Locality for the purpose of

estimating the amount of the damage done. This was found to be very considerable, the vermin eating the pale and succulent bases of the grass, as well as the young shoots. No great destruction of other vermin has occurred in the district, so it cannot be said that the Voles have become particularly abundant from that cause. Similar plagues have before now occurred in the New Forest.

A SCIENTIFIC Society and Field Club has been formed in the northern burgh of Inverness. We have received the inaugural address of the President, Mr. William Jolly, on "The Scientific Materials of the North and our Scientific Work." Mr. Jolly has lofty ideas of what the work and influence of such a society should be, and we hope his address will have a stirring effect upon the members. Inverness is a fine centre for a field-club, especially in the region of geology. We are also glad to see that a Monmouthshire Geological Society has just been formed; its first general meeting was held on the 2nd inst.

THE *Geographical Magazine* for May contains an article on the prospects for the Arctic Campaign of 1876. While we must be prepared for the necessity of the ships spending a second winter in the north, the writer thinks that possibly the *Pandora*, which goes out this month for news and letters, may meet them coming out of Smith Sound, "with their work done, their great enterprise completed." There is also an article, with map, on the Island of Socotra, which the British Government have arranged to occupy, and another by M. Venyukof on New Maps of Mongolia.

THE Supplementary Part, 46, of *Petermann's Mittheilungen* consists of a valuable memoir on the Pekin Plain and the neighbouring Mountain-land, by Dr. Bretschneider, Physician to the Russian Embassy at Pekin. It is accompanied by a map of Pekin and the district around.

AT the Royal Geographical Society on Monday the following papers were read:—"The Country and Natives of Port Moresby, New Guinea," by Mr. O. C. Stone, and "The Natives and Products of Fly River, New Guinea," by Signor L. M. D'Albertis. Mr. Stone's paper gave some details of the country and the people, speaking, on the whole, well of the latter. Signor D'Albertis's paper gave somewhat similer details as to the country in the neighbourhood of the Fly River. Dr. Mullens read a few notes, in which he described the details of his excursions in different parts of Central New Guinea. Sir Henry Rawlinson hoped a "Cameron" for New Guinea would soon turn up, and that Mr. Young would be the coming explorer, and would force himself into the large and comparatively unknown regions of New Guinea.

LETTERS from Sydney, dated March 17, inform us that the Governor of New South Wales has provided M. D'Albertis with a steam-launch for the exploration of the Fly River, and that he was intending to return to New Guinea ten days later. A public meeting was to be called at Sydney to provide for M. D'Albertis's other expenses in connection with the expedition.

AT the Crystal Palace Aquarium the hatching of the spawn of Axolotls has been successfully accomplished. There are three young "broods," and some still unhatched spawn, so that the changes in growth during the first few weeks can be seen all together.

WE greatly regret to learn that the Massachusetts House of Representatives have by a majority refused to entertain at present any proposal for a new and much-needed survey of that state. We referred to the matter about a year ago, when everything promised well (vol. xi. pp. 381, 497). We can only hope that the present unpatriotic mood of the Legislature will not last long.

ON Monday and Tuesday-week the first Annual Meeting of the Cumberland Association for the Advancement of Literature and Science was held at Whitehaven, when an instructive inaugural address was given by the Bishop of Carlisle, the President of the Association. Other interesting papers were read and excursions made, including a geological excursion along the coast under the guidance of Mr. J. C. Ward, and others. Accounts of some of the confederated societies were given, and altogether this first meeting of the Association promises well for its future and for the cause of culture in Cumberland.

THE Cape of Good Hope University has decided to throw open unreservedly degrees, honours, and pecuniary emoluments at the disposal of that body to candidates who desire to be examined in places beyond the bounds of the Cape Colony, provided the Government of the Colony or the State in which such candidates reside shall be annual contributors of 200*l*. to the funds of the University.

DR. M. T. MASTERS has been experimenting on the functions of the nectaries formed by the small cup-shaped petals of *Helleborus*, and finds that they absorb or digest nitrogenous substances, repeating in all respects the phenomena of the leaves of *Drosera* and *Dionæa*.

WE have received from Prof. Sachs a reply to Reinke's series of papers "Untersuchungen uber Wachsthum" in the "Botanische Zeitung" challenging the correctness of experiments made in Prof. Sachs's laboratory at Würzburg on the rate of growth of plants; also a lecture on the "Nourishment of Plants," giving a popular account of the state of our knowledge respecting the phenomena of plant-life.

M. VOGEL, of Munich, has observed, says the *Belgique Horticole*, that seeds germinate much more quickly when watered with water containing camphor than with pure water.

THE Rev. S. J. Perry, F.R.S., has reprinted, in a separate form, his "Notes of a Voyage to Kerguelen Island to observe the Transit of Venus," from the *Month*. These Notes refer not only to the immediate object of the expedition, but describe in a pleasant way the voyage out and the nature of the desolate island which was the home of the various expeditions for many weeks. Many, besides astronomers, will find the narrative interesting and instructive. H. S. King and Co., are the publishers.

FROM Prof. O. C. Marsh we have received a paper on the principal characters of the Brontotheridæ (Titanotheridæ of Flower, NATURE, vol. xiii. p. 327), in which several additions are made to our knowledge of the group. Four genera are described, differing in the number of the always feebly developed incisor teeth. The brain-case is shown to have been small. The toes were the same in number as in the existing Tapirs, four in front and three behind. All the known remains of these animals are from east of the Rocky Mountains, in the Miocene beds of Dakota, Nebraska, Wyoming, and Colorado. Figures of the skull, teeth, brain cavity, and feet, accompany the description.

THE additions to the Zoological Society's Gardens during the past week include three Brown Howlers (*Mycetes fuscus*) from New Granada, a Brazilian Tree Porcupine (*Cercolabes prehensilis*) from South America, deposited; two Leopards (juv.) (*F... pardus*) from India, presented by Mr. Ge... W.I. Regiment; a Grey Ichneum... (*Herpestes griseus*) from India, presented by ... W. H. Worth; five Water Ouzels (*Cinclus aquaticus*), European, presented by Mr. Frederick Swabey ... a Black-headed Gull (*Larus ridibundus*), a Herring Gull ... (*Larus argentatus*), European, presented by Mr. Brazenor; a C... Collection of Marine Fishes from the British Seas, presented by Dr. A. H. Smee; five Common Rabbits (*Lepus cuniculus*) European, deposited by Master B. Sclater; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, purchased; twenty Land Crabs from the Ascension, presented by Mr. Wm Drew.

SCIENTIFIC SERIALS

THE *Quarterly Journal of Microscopical Science* contains several papers of importance. The first is by Dr. Klein, entitled "Observations on the Early Development of the Common Trout (*Salmo fario*)," in which the condition of the blastoderm between the third and thirteenth day is described. The subject is minutely treated, and the bibliography is very complete.—Mr. John Priestley gives a *résumé* of recent researches on the nuclei of animal and vegetable cells, and especially of ova, and afterwards collates the various statements, indicating their points of divergence.—The investigations of Prof. E. Auerbach and Strasburger, of Dr. Oscar Hertwig and Van Beneden, are those discussed.—M. Edouard Van Beneden's valuable "Contributions to the History of the Germinal Vesicle, and of the first Embryonic Nucleus" contains much of special interest with reference to the relation of the germinal vesicle and the first cleavage nucleus of the egg, especially with reference to the different results arrived at by the author in his study of the ovum of the rabbit, and M. Hertwig's investigations on the echinoderm *Toxopneustes lividus*.—Mr. H. R. Octavius Sankey gives a new method for examining the structure of the brain, and reviews some points in the histology of the cerebellum. The dye employed for the staining is aniline blue-black, in which sections of fresh brain should remain twelve hours or so, and afterwards be dried.—Dr. James Foulis gives a lengthy memoir on the development of the ova and structure of the ovary in man and other mammalia. Three plates accompany his paper. The author mainly devotes himself in this communication to the description of the appearances in the ovaries of young kittens, and of the human fœtus, with the object of demonstrating, in particular, that whereas the eggs are derived from the germ epithelium, the nutrient cells of the ovum, or the follicular epithelial cells, are derived from the cells of the stroma of the ovary.—Dr. Carpenter, in a paper on the genus *Astrorhiza* of Sandahl, lately described as *Haeckelina*, by Dr. Bessels, reintroduces the earlier account of the genus, and figures it.

Journal of Botany.—Among the more important articles on descriptive and systematic botany in this periodical since the commencement of the current year are a description of *Rumex rupestris*, Le Gall, as a British plant, by Dr. Trimen, with a plate: a description of four new species of Fuchsia from South America, by Mr. Hemsley, and a conspectus of the genus *Glycosmis*, by Mr. Kurz, with two plates. Mr. Sorby contributes a paper on the colouring matter associated with chlorophyll, in which he combats some of the conclusions of Pringsheim, and Prof. Church some further notes on plant-chemistry, with analyses of *Lactuca sativa*, *Chondrus crispus*, in which the ash reaches the very large amount of 14·15 per cent. of the air-dry plant, and *Nasturtium officinale*, and of the ash of the bud-scales of the beech, and of the female flowers of the elm. In the April number is the commencement of Prof. De Bary's very important report of researches into the nature of the potato-fungus, *Phytophthora infestans*.

Although the articles in the *Scottish Naturalist* are mainly of local interest, two notable exceptions are furnished by those on "Animal Psychosis," by the Rev. J. Wardrop, and "Illustrations of Animal Reason," by Dr. Lauder Lindsay, portions of which occur in the numbers for January and April, both of which we hope to see reprinted in a form to reach a larger public. There are a large number of notes on the zoology of Scotland, and Mr. A. Sturrock records an addition to the flora of that country in the discovery, in Loch Cluny, Perthshire, of *Naias flexilis*, hitherto confined to Ireland as far as the British Islands are concerned. Dr. Buchanan White and Dr. Sharp continue their lists of the Lepidoptera and Coleoptera of Scotland respectively.

Poggendorff's Annalen der Physik und Chemie, No. 1, 1876. —In Regnault's experiments on the specific heat of gases, it was necessary that the spiral through which the gas streamed should have considerable length, so that the gas might fully take the temperature of the heating vessel, and fully yield up its heat in the calorimeter. A correspondingly large size of vessel and a large quantity of gas were required. In a new investigation by E. Wiedemann, here described, the chief object was to diminish the calorimeter, and yet not compromise the yield of heat of the gas, that is, to afford the heated gas as great a surface in as small a space as possible. His heating vessel was a copper cylinder stuffed with copper turnings and enclosed in another copper vessel containing water or paraffin to be heated. In the calorimeter the gas passed successively through three vertical and connected silver pipes filled with silver turnings, and gave its heat to the surrounding liquid. The author shows that his method is not behind that of Regnault in accuracy, and as the quantity of water was only a tenth of that which Regnault used, only a tenth part of the gas was required, to obtain as great elevation of temperature. Thus extensive results could be had in shorter time. The tabulated numbers for the seven gases examined do not materially differ from those of Regnault.—A paper by Dr. Dvorak follows, describing many interesting experiments on acoustic attraction and repulsion. He studies the case of rods in transverse vibration; also the action of a screen in a sound wave; acoustic attraction and repulsion of resonance; also that in liquids and the phenomena in air columns thrown into continuous vibrations.—The observations of M. Plateau on liquid films are extended by Dr. Sondhauss, who endeavoured to determine the extent to which different liquids could be stretched in films in wire rings, observed such lamellæ in closed vessels excluding external disturbances, measured with a balance their tension, and, with a manometer, the pressure of bubbles on the enclosed air; he also measured the weight of such lamellæ and bubbles, whence their thickness might be inferred. With a simple contrivance, consisting of a thin wire bent horizontally to an angle and a straight wire placed across and drawn gradually away from the angle, it may be shown that all liquids can be stretched in lamellæ, and different liquids may be compared in this respect. But Dr. Sondhauss prefers the circular wire rings. He compares (as to size) the films got from forty-six different liquids. Among some facts relating to durability of films, we note that one film from a quillaja decoction, to which a little glycerine had been added, was produced in a vessel on 1st Sept., 1872, and lasted till 11th March, 1873, or over half a year.—M. Groth communicates the results of a study of the elasticity of rock salt by observation of the velocity of sound in different directions in it, a method more easily carried out than that of M. Voigt, who measured the elastic bending of rods of the substance. The researches of both leave no doubt that in regular crystals the coefficient of elasticity, and therewith the velocity of sound, is a function of the direction; and in accordance with Neumann's theory, they vary symmetrically with reference to the planes of symmetry of the crystal. A geometrical plane of symmetry of a crystal is at the same time a physical plane of symmetry. A crystal may be defined as a homogeneous solid body whose elasticity varies with the direction.—We further note the first part of a valuable paper by M. Grotrian, on the constants of friction of some salt solutions and their relations to galvanic conductivity; and some observations of M. Edlund on the connection of galvanic induction with electro-dynamic phenomena; also, extracted papers on the occurrence of nitrogenous iron among the fumarole products of Mount Etna, and on the thermo-electric properties of some calcareous spar, beryll, idocrase, and apophyllite.

Revue des Sciences Naturelles, December, 1875.—The most interesting original observations recorded in this number are contained in a short paper by D. A. Godron, on fertilisation of flowers by Hymenoptera. Near Nancy it is found that the hybrid produced by the fertilisation of *Primula grandiflora* with pollen of *P. officinalis* results from the intervention of bees, but the converse hybrid does not occur. M. Godron published an account of this in 1844. The reason for the non-occurrence of the second hybrid is that *P. grandiflora* flowers earlier in this locality than *P. officinalis*. M. Godron was able to produce the hybrid *P. grandiflora-officinalis* artificially, but never saw it as a natural product till March, 1874, when it was brought to him from a locality two kilometres distant from the first. On investigation it was found that only *P. officinalis* grew at this spot, and that owing to situation and surroundings it flowered much earlier than in the other locality; but the hybridisation could only be effected by the carrying of the pollen of *P. grandiflora* two kilometres by bees.—The summaries of French memoirs on science are full and valuable; foreign summaries of moderate extent are likewise given.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 4.—"On the Absorption-Spectra of Bromine and Iodine Monochloride," by H. E. Roscoe, F.R.S., and T. E. Thorpe.

The paper contains the results of an exact series of measurements of the absorption-spectra of the vapours of the element bromine and of the compound iodine monochloride, made with the object of ascertaining whether the molecules of these two gases vibrate identically or similarly, their molecular weights and colour of the vapours being almost identical.

A careful comparison of these Tables and of the map shows that, although both spectra contain a large number of lines which are nearly coincident, the spectra as a whole are not identical, either when the vapours are examined at high or low temperatures, or when the length of the columns of absorbing gas are varied.

Linnean Society, April 20.—G. Bentham, F.R.S., vice-president, in the chair.—Mr. Hudson, Dr. Prior, Mr. Stainton, and Mr. C. Stewart were appointed auditors for the current year.—Dr. Hooker, P.R.S., exhibited some specimens illustrating a communication from Dr. J. Kirk, which was read. This latter referred to the identification of the modern copal tree, *Trachylobium Hornemannianum*, with that which yielded the Zanzibar Copal or Gum Animi, now found in the earth on the east coast of Africa, and often where no copal yielding tree now exists. Little doubt now rests as to the identity of the semi-fossil with the living tree, inasmuch as bijugate leaf, flower-bud, flower, ovary and stamens, characteristic of the latter have been discovered in the so-called Animi. Dr. Kirk is inclined to account for their difference in quality by a molecular or chemical change in the buried material; improving it thereby, and as a consequence increasing its market value.—Mr. W. P. Hiern read a paper "On the African species of the genus *Coffea*, Linn." As at present understood this genus belongs to the Old World, and the numerous American species that have previously been referred to it, now find places in other genera. All the species most valuable for economic or commercial purposes are confined to Africa or are of African origin. Of the seven Indian species, one formerly was cultivated, but from its inferiority has since been discarded in favour of the African plants. The so-called wild coffee of Sierra Leone and Fernando Po, and other berries, are occasionally used by the inhabitants of those places as coffee; but they do not belong to the genus in question. The author distinguishes and technically characterises some fifteen species of coffee plant as indigenous to Africa and its adjacent islands. They are:—1. *C. arabica*, 2. *C. liberica*, 3. *C. stenophylla*, 4. *C. zanguebariæ*, 5. *C. brevipes*, 6. *C. melanocarpa*, 7. *C. mauritiana*, 8. *C. Macrocarpa*, 9. *C. hypoglauca*, 10. *C. microcarpa*, 11. *C. afzelii*, 12. *C. subcordata*, 13. *C. rupestris*, 14 *C. jasminoides*, 15 *C. racemosa*. He rejects some six supposed species of African Coffees, showing these belong to other groups. Of the 15 species, 13 inhabit the African Continent, and 2 pertain to Mauritius and Bourbon; so far as yet explored, West Africa furnishes 11 species, and but two are found in East and Central Africa. Mr. Hiern describes numbers 2, 5, 11, 12, and 13, viz., five in all as new species, and three others are MS. names of specimens in the herbarium of the late distinguished botanist, Mr. Welwitsch. He alludes to a pale-berried variety of the *C. arabica* found by Vogel in Sierra Leone. By far the most interesting new plant commercially and otherwise is the Liberian Coffee introduced into this country in 1874, by Mr. W. Bull, the horticulturist. This is said to be far superior to the ordinary coffee of commerce, *C. arabica* having larger berries, a finer flavour, and being at the same time more robust and productive.—A paper "On the Classification of *Narcissus*," by Mr. Shirley Hibberd, was announced.—Mr. Thiselton Dyer read a note "On the Plant yielding Lattakia Tobacco," and exhibited specimens corroborating the conclusions arrived at by him. These latter are that Lattakia tobacco is produced by a different species to the Turkish, and that as imported into this country it consists of the flowering twigs made up into bundles which have been smoked with pine wood.—Prof. Dickie had a summary read of a further contribution of his to the botany of the *Challenger* expedition, viz., a List with Remarks of the Polynesian Algæ collected by Mr. Mosley. Only a very few species appear to be new to science.—Dr. Hooker communicated a paper of P. F. Reinsch's, on New Freshwater Algæ obtained by the Venus Transit Expedition in the Island of Kerguelen. This being technical in character, was taken as read.

Chemical Society, May 4.—Dr. Gilbert, vice-president, in the chair.—Eight communications were made to the Society, namely:—On glycero-phosphoric acid and its salts as obtained from the phosphorised constituents of the brain, by Dr. J. L. W. Thudicum and Mr. C. T. Kingsett.—On some reactions of biliverdin, by Dr. Thudicum.—On the r between chemical constitution and colouring power in a substances, by Dr. O. Witt.—On certain bismuth comp by Mr. M. M. P. Muir.—A new method for preparing hydrocarbons diphenyl and isodinaphthyl and on the ac a high temperature of metallic chlorides on certain hydrocarbons, and a note on the occurrence of benzene in rosin s, both by Mr. W. Smyth.—On the action of water and saline solutions on copper, by Mr. T. Carnelly, and notes on riments made to ascertain the value of a proposed method determining the mineral strength of soils by means of wat culture, by Mr. G. W. Hight.

Zoological Society, May 2.—Robert Hudson, F.R.S., vice-president, in the chair.—Mr. G. Dawson Rowley exhibited and made remarks on a specimen of *Machærirhynchus nigripec* from New Guinea, believed to be the first example of this bird which had reached this country.—Extracts were read from several letters received from Dr. George Bennett, F.Z.S., giving some account of the proceedings of Mr. L. M. D'Albertis, and of his recent expedition up the Fly River in December, 1875.—Mr. J. H. Gurney, jun., exhibited and made remarks on an example of the Lesser White-fronted Goose, from Egypt, being the first record of the occurrence of this species in Africa.—Mr. Osbert Salvin, F.R.S., exhibited and made remarks on a piece of a trunk of a pine from Guatemala, which had been perforated by a Woodpecker (*Melanerpes formicivorus*), for the purpose of storing acorns.—Mr. A. Grote exhibited and made remarks on Col. Gordon's drawing of *Ovis polii*, which was the original of the figure given in the Society's *Proceedings* for 1874.—George Busk, F.R.S., read a memoir on the Ancient or Quaternary Fauna of Gibraltar, as exemplified in the Mammalian remains of the ossiferous breccia, which occurs in the caves and fissures recently explored in different parts of the rock.—Mr. Busk, after a preliminary description of the geological features of the rock and its fossiliferous caverns and fissures, treated specially of the various bones of the bear, cat, horse, rhinoceros, stag, ibex, and other animals, of which the remains occur there, and proceeded to refer them to the species to which they seemed to belong.—Prof. A. H. Garrod read a paper on the anatomy of the Colies (*Colius*), which he regarded as belonging to the Piciform group of the division of Anomalogonatous birds according to his arrangement, but constituting an independent family.—A communication was read from Mr. E. L. Layard, containing the description of a new Blackbird (*Turdus*), from Taviuni, one of the Fiji Islands. The Rev. Canon Tristram read a note on the occurrence of the Roebuck in Palestine.

Geological Society, April 26.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—The Rev. Edwin Hill, M. was elected a Fellow, and Prof. Beyrich, of Berlin, a Fo member of the society. The following communications read: A translation of the notice by Capt. Miaulis of the royal navy, of the occurrence of a submarine crater with Harbour of Karavossera, in the Gulf of Arta. Commun by the Secretary of State for Foreign Affairs.—"The p history of the Dee, Wales," by Prof. A. C. Ramsay. The author stated that he regarded the valley of the mainly preglacial throughout, and sketched the physical h of the region through which it runs. The silurian rocks much disturbed and denuded before and during the Carboniferou period, and the carboniferous limestone was deposited very conformably on the upturned edges of both lower and upper silurian strata, and once spread all over the region, probably overlaid by the millstone grit and coal-measures, as now in the east of Denbighshire and Flintshire. The region was again disturbed and elevated during the formation of the Permian deposits, and then by sub-aerial denudation a great part of the carboniferous series was removed down to the old plain of denudation of the Silurian rocks, the surface of which thus probably stood higher than it does at present, being in the midst of a broad continental area. From a consideration of the conditions of deposition of the Mesozoic and Tertiary formations the author concluded that, from the beginning of the Permian to that of the Glacial epoch, the higher ground of Wales was land well raised above the sea, except perhaps during the deposition of the chalk, and th during all this period it was exposed to the influence of su aerial agents of denudation. He indicated the condition elevation of the old table-land of carboniferous rocks, showed that it had probably a slope towards the east and cast to the extent of about 23 feet in a mile. The drainag this land then flowed in an easterly and north-easterly direc

along the earliest channel of the Dee, which would be at an elevation from 1,300 to 1,400 feet higher than the present channel. During the Glacial epoch ice-action deepened, and more or less modified the existing channel, and scooped out the basin of Bala Lake, which was not previously in existence. The general results of this investigation are as follows:—After the last important disturbance of the pre-Permian rocks, North Wales was carved slowly and by sub-aërial agencies into its present mountainous form, chiefly between Permian and Preglacial times. The work of the glaciers of the latter period somewhat deepened, widened, smoothed, and striated the minor outlines of the mountains and valleys, and excavated many rock-bound lake-basins, but did not effect any great changes in the contours of the country. A minor submergence of part of Britain during part of the Glacial epoch produced no important effects on the large outlines of the rocky scenery; and the effects of sub-aërial waste subsequent to the Glacial epoch have been comparatively small.—On the Ancient Volcano of the District of Schemnitz, Hungary, by Mr. John W. Judd. The old volcanoes of Hungary have long been known to present some very interesting illustrations of the relations between the igneous rocks erupted at the surface, and those which have consolidated at a considerable depth beneath it. The district in which these phenomena can be best studied is that of Schemnitz; but although this area has been very carefully mapped and explored by a number of able investigators, the greatest diversities of opinion still exist concerning the relations of certain of the rock-masses exposed within it. Over an area nearly fifty miles in diameter enormous accumulations of *andesite* and *quartz-andesite* lavas and agglomerates have been erupted, these now forming a group of mountains rising from 3,000 to 4,000 feet above the sea-level, and culminating in a great ring of precipitous heights overlooking a depressed central area of oval form, the site of the famous mining towns of Schemnitz, Kremnitz, and Konigsberg. In the midst of this depressed central area there occurs a considerable development of *rhyolitic* lavas and tuffs, and more scattered outbursts of *basalt*. From the magnificent floras associated with the various volcanic tuffs, we know that the andesitic rocks were erupted during the earlier portion of the Upper Miocene period and the rhyolitic towards its close, while the basalts are probably of as late date as the Pliocene. Besides the rhyolites and basalts, however, there are certain other rocks exposed in the central area of the Schemnitz district, the relations of which it is very difficult to understand. These consist of (1) strata of Lower Trias and Nummulitic age, through the midst of which the volcanic outbursts have evidently taken place; (2) masses of highly metamorphic rocks, including quartzites, crystalline limestones, various schists, gneiss and aplite; and (3) undoubted eruptive rocks, which have usually been called "syenite and granite," but for which the names of "diorite and quartz-diorite" would perhaps be more appropriate, inasmuch as the prevailing felspar in them is always a plagioclase variety. By Beudant and other early writers the andesitic lavas were recognised as volcanic products of a comparatively recent geological period, while the "granite, syenite, and greenstone," were regarded as being of far more ancient date. By von Pettko, Richthofen, and all the more recent investigators of the district, however, it has been clearly perceived that the "greenstones" are certainly, like the andesites, of Tertiary age, and hence such names as "greenstone-trachyte" and "propylite" have been applied to them. The studies of the author of the present memoir, both in the field and in the cabinet, have led him to the conclusion that the granitic, porphyritic, and lava rocks—which were formerly called "syenite," "greenstone," and "trachyte" respectively—*are all of similar composition and equivalent age*, and that they differ only in their more or less perfect state of crystallisation, the result evidently of variations in the conditions under which they have consolidated. He is further led to regard the metamorphic masses, around the several intrusive centres as being not, as has hitherto been maintained, of "Primary" (Devonian or Permian) age, but simply Triassic rocks affected by local or contact metamorphism. The real structure of the great Schemnitz volcano was first recognised by von Pettko in 1848, though this author erroneously regarded it as presenting an example of a "crater of elevation." The history of the formation and destruction of this volcano is now shown to be as follows:—After some small and scattered outbursts of rocks of acid composition towards the close of the Oligocene period, the grand eruptions of andesitic lavas of the Miocene began, through the agency of which a volcano of larger dimensions than Etna was gradually built up, by both central and lateral eruptions. In the midst of this volcano a crater of enormous dimensions was formed, doubtless by some great paroxysmal outbreak, and by the subsequent subsidence of the mountain the sea gained access to, and by denudation greatly enlarged the area of this "Caldera." Then in the central lagoon of the caldera a number of minor eruptions, first of acid and then of basic rocks took place; and the volcano, which at this period of its history must have closely resembled the existing island of Santorin, was again upheaved from beneath the sea, and exposed to the wasting effects of subaerial denudation. The gradual decline of the volcanic forces in the district was marked, as is usually the case, by the appearance of hot and mineral springs, discharges of gas, occasional earthquakes, &c. While affording such remarkable examples of the perfect transition between the so-called plutonic and the volcanic classes of rocks, and of the phenomena of contact metamorphism, the granitic masses of the Schemnitz district are without question truly *intrusive*; and a careful study of them lends no support whatever to the hypothesis that such rocks may be formed by the extreme metamorphism of sediments *in situ*. There is the most complete proof that in the Schemnitz district the formation of true mineral veins, containing gold, silver, and other metals, has taken place within the most recent geological periods; in some cases, indeed, at a later date than the Pliocene.

Institution of Civil Engineers, April 25.—The first paper read was descriptive of the "Dhu Heartach Lighthouse," by Mr. David Alan Stevenson, B.Sc.—The second paper read was "On the changes in the tidal portion of the river Mersey, and in its Estuary," by Mr. James N. Shoolbred, B.A., Assoc. Inst., C.E.

May 2.—Mr. George Robert Stephenson, president, in the chair.—The paper read was on fascine work at the outfalls of the Fen Rivers, and reclamation of the foreshore, by Mr. W. H. Wheeler, M. Inst. C.E.

BERLIN

German Chemical Society, Feb. 28.—A. W. Hofmann, president, in the chair.—H. Ritthausen described a crystalline constituent of vicia sativa vicin, $C_8H_{16}N_3O_6$, which, treated with sulphuric acid, yields a sulphoconjugated acid, exhibiting blue reactions with baryta water and ammonia.—R. Schiff has transformed chloraechyl-aldehyde by heating it with acetate of potassium into the diacetate of ethylidene. The former body is therefore chlori-acetate of ethylidene,

$$CH_3\text{--}CH.Cl\text{--}O\text{--}CO\text{--}CH_3.$$

—R. Barth, by treating resorcine with hydrochloric acid, has produced an anhydride of resorcine, $C_6H_4OH.O.C_6H_4OH$, a dichroic substance, green in reflected light and red in solution.—O. Wilf published considerations on the constitution of organic dyes.—M. Nencky has found indigo in the urine of dogs fed with indol.—A. Oppenheim reported on various researches on aceto-acetic ether. Together with H. Precht, he has simplified the method for obtaining this substance in large quantities. The vapour density has been taken, and it has been explained why no hydrogen is evolved during the action of sodium on acetic ether; the reason being the transformation of acetyl, CH_3CO, into oxethyl, CH_3CH_2O. The same chemists have discovered a practical method for obtaining dehydracetic acid, $C_8H_8O_4$, by passing aceto-acetic ether through heated iron tubes. They described its ethyl-compound and the action of potash on dehydracetic acid: $C_8H_8O_4 + 3H_2O = 2C_2H_4O_2$ (acetic acid) + C_3H_6O (acetone) + CO_2. Baryta forms at the same time a substance resembling orcine. The same chemists found acetic ether, when heated, to yield ethylene and acetic acid.—A. Oppenheim and C. Emmerling have studied the action of oxydising agents on oxyuritic acid. The result is an acid, $C_7H_8O_3$, to which they give the name of hydro-oxybenzoic acid. By fusion with potash, it yields benzoic acid and water.

March 13.—A. W. Hofmann, president, in the chair.—Dr. Radziszewsky has transformed phenylacetic acid

$$C_6H_5 . CH_2 . COOH$$

into the corresponding aldehyde and alcohol; phenyl-ethyl-alcohol $C_6H_5 . CH_2 . CH_2OH$, liquids boiling at 207° and 212°. —F. Salomon has compared the properties of oxalurate of ethyl obtained by synthesis from urea with chloro-oxalate of ethyl with that obtained from oxalurate of silver. He has found them identical in the properties. Amongst other reactions he remarks that both with oxide of silver yield parabanate of silver. —V. Meyer and several of his pupils revert to the reaction which mixed azocompounds:—

$$C_6H_5N_2NO_3 + C_2H_4NO_2Na = NaNO_3 + C_6H_5N_2C_2H_4NO_2$$
Nitrate of diazobenzol — Sodium-nitro-ethane. — Nitro-ethyl-azophenyl

By generalising this reaction the following compounds have been prepared:—By V. Meyer: azonitropropylphenyl,
$$C_6H_5N_2C_3H_6NO_2;$$
by T. Barbieri: azonitroethylparabolyl, $C_7H_7N_2C_2H_4NO_2$; and azonitrophenylorthobolyl, $C_7H_7N_2C_2H_4NO_2$; by H. Wald: azonitroethylparabromophenyl, $C_6H_4BrN_2C_2H_4NO_2$; by F. Hallmann: azonitroethylnitrophenyl, $C_6H_4NO_2N_2C_2H_4NO_2$.—V. Meyer and M. Lecco described the following reaction:—
$$CH_3CH_2CBr_2(NO_2) + H_2NOH = 2HBr +$$
Dibromonitropropan. Hydroxylamine.
$$CH_3 . CH_2 . C = NOH(NO_2).$$
Propylnitrolic acid.

—W. Michler described the following reactions:—
$$COCl_2 + NH(C_6H_5)_2 = HCl + CO^{Cl}_{N(C_6H_5)_2}.$$
Oxychloride of carbon. — Diphenylamine — New chloride.

This, with ammonia, yields the urea, $CO(NH_2) . N(C_6H_5)_2$; and with aniline the urea, $CO(NHC_6H_5) . N(C_6H_5)_2$. Oxychloride of carbon and ethylaniline yields the chloride—
$$CO^{Cl}_{N(C_6H_5)(C_2H_5)}.$$
If, instead of monoethyl-aniline, dimethylaniline is submitted to the action of oxychloride of carbon, the reaction passes in a different manner, namely:—
$$2N(C_6H_5)(CH_3)_2 + COCl_2 = HCl\ N(C_6H_5)(CH_3)_2 +$$
Dimethylaniline — Hydrochlorate of dimethylaniline
$$N(CH_3)_2C_6H_4COCl$$
Chloride of dimethylamidobenzoic acid

The acid is easily obtained, and proves to be identical with dimethylamidoparabenzoic acid.—P. Claessen proved the identity of rhodan-acetic acid of Heintz with what Vollhardt called isosulfocyano-acetic acid.—C. Reimer has obtained the following very remarkable result of the action of chloroform on an alkaline solution of phenol, viz., salicylous acid. This reaction may be generalised. Cresol and other phenols offer similar results.—O. Braun described an apparatus destined to retain the solid and liquid parts of smoke, as also those parts that may be absorbed by solids or liquids. He likewise described a similar apparatus for retaining sparks.—E. Schunk and H. Roemer gave details on the preparation of isoanthraflavinic acid and a comparison of its properties with anthraflavinic acid. The described substitution-derivatives with four atoms of bromine and with two molecules of acetyl, ethyl, and methyl respectively.—F. Tieman has transformed vanilline by acetic anhydride into a coumarine. The corresponding acid is ferulic acid. He drew attention to the relation of vanillinic and coniferylic derivatives which corresponds to that of benzoic and cinnamic compounds.—F. Tiemann and H. Haarmann have found in vanilla besides vanilline, vanillic acid, resin, and fat.

PARIS

Academy of Sciences, May 1.—Vice-Admiral Paris in the chair.—The following papers were read:—Discovery of the small planet (163), M. Leverrier. It was discovered at Toulouse, April 26, by M. Perrotin.—On the electro-motive forces produced on contact, of liquids separated by capillary diaphragms of any nature, by M. Becquerel. Using dilute instead of concentrated liquids, he finds the electromotive force increases with the time of contact reaching a maximum. The action probably consists of a condensation of acid and alkaline particles on the faces of the diaphragm, just as gases are condensed in porous bodies.—On the oscillations of temperature of half January, half February, and half April, 1876, by M. Sainte-Claire-Deville. In April there was a minimum about the 15th; in January and February about the 12th.—On microclinic felspar and on andesine, by M. Sainte-Claire-Deville.—Microscopic examination of orthose and of various triclinic felspars, by M. Des Cloizeaux.—On electric polarisation, by M. Du Moncel. An electrified plate sheathed with oxygen may produce a different effect from an unelectrified plate so sheathed, the electric vibrations continuing after the electric source has ceased (phosphorescence is analogous). The author studies this with hard stones, he also studies the effects of polarisation with induced currents, effects of local currents in stones, &c.—Note on the theory of several hydraulic machines of his invention, by M. De Caligny.—On the embryogeny of Ephemera, especially that of *Palingenia virgo* (Olivier), by M. Joly.—On fishes of the Ceratodus group in the river Fitzroy, Australia, by M. de Castelnau.—New researches on gallium, by M. Lecoq de Boisbaudran.—Experiments on solar heat, by M. Salicis. A sealed packet (of 1868) relating to utilisation of solar heat by reflectors, &c. He describes a heliodynamic and a heliostatic apparatus.—Researches on the compounds of pure carbon in meteorites, by Mr. J. Lawrence Smith.—On the Phylloxera which comes from the winter egg, by M. Boiteau. Direct application of sulphide of carbon in the treatment of phylloxerised vines, by M. Allies.—On a new mode of cultivation of the vine without pruning, by M. Martin.—On the employment of the method of articulation in education of deaf mutes, by M. Houdin.—Observations of planets at the Observatory of Marseilles, by M. Stephan.—Phenomena of interference obtained with thin sheets of collodion, by M. Gripon.—On the distribution of magnetism in cylindrical bars, by M. Bouty.—On the transmission of electric currents by derivation across a river, by M. Bouchotte; an experiment made in 1858. An air line of 300 m. (with battery) on one bank of a river, was connected by both ends to earth, and a similar line on the other bank contained a galvanometer. On the battery circuit being closed, the needle was deflected.—On a new system of electro-magnet with flat spirals, by M. Serrin. The wires of bobbins of electro-magnets, used in regulators of powerful electric lights, sometimes become so hot as to fuse the insulating matter surrounding them. M. Serrin forms his electro-magnet spirals of metallic helices without insulating cover, and so arranged that the spirals cannot touch one another. He hollows out his helice from a copper cylinder of thickness equal to that of the bottom, and he covers the coil with vitreous enamel. The spiral may be raised to a red heat without the sensibility of the apparatus being affected. On a new sulphate of potassium, by M. Ogier.—On the origin of stripe in puddled iron, by M. Le Chatelier. The stripe results from small fusibility of partially peroxidised scoriæ, and from the comparatively low temperature at which the puddling is done.—On a new crystallised organic substance, by M. Loiseau. It is called *raffinose*, and was got in investigating the most favourable conditions for extraction of sugar from molasses by means of the sucrate of hydrocarbonate of lime. Crystallised raffinose has the formula $C_6H_7O_7$.—On a new method of studying the respiration of aquatic animals, by MM. Jolyet and Regnard. The object is to keep the medium always in the normal state, however long the experiment. In a limited closed space, containing determinate quantities of water and air, it was required to make air circulate in the water, to absorb the CO_2 in proportion as it was exhaled, and replace O as it was consumed. A figure of the apparatus is given.—On the crystalline system of various substances presenting optical anomalies, by M. Mallard.—The elephants of Mont Dol; dentition of the mammoth; distinction of upper and lower molars, right and left, by M. Sirodot.—On the cranial cavity and the position of the optic orifice in *Steneosaurus Heberti*, by M. Morel de Glasville.—On a new thermo-cautery, by M. Paquelin. It depends on the property which platinum has, of becoming incandescent (once it has been raised to a certain degree of heat) in a gaseous mixture of air and of certain hydrocarbonised vapours.

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others, the qualities in which they themselves are deficient. Aided in the work of comparison by the purely scientific system of classification now first adopted, the investigator will find much to suggest new trains of thought, as the science teacher will find new and improved means for inculcating the truths of nature. While the scientific instructor, the student, and the mechanician will find enough to absorb their interest, the general public will find infinite interest in much of the apparatus exhibited.

"There are already indications that the magnificent collection of scientific treasures brought together at the cost of much ability and energy on the part of the authorities of the South Kensington Museum will hardly be permitted to suffer redistribution to the four corners of the earth. Certain precious relics—the pride of Universities and museums—will probably be claimed at the conclusion of the Exhibition by their proper owners; but it is more than doubtful whether the makers of many of the most perfect modern instruments would not prefer them on view for an indefinite period rather than withdraw them altogether. Many of them have signified their willingness to present the nation with their exhibits out of hand, and there are other signs that a project not new, but dormant for some time past, will shortly be revived. It is that of establishing in London an analogue of the Conservatoire des Arts et Métiers at Paris, of which a very poor imitation, if it can be called an imitation at all, exists in the Patent Museum. The present opportunity of forming a scientific and industrial museum, which would be the envy of Europe, appears to many scientific people too good to be lightly foregone."

The *Standard*, in an article on Wednesday last week, says:

"The result is a collection which will delight the heart of every scientific man, and even to those who merely dabble in science the interest will be very great. . . .

"That the new loan collection of scientific instruments will be an exhibition popular with and largely frequented by the general public was probably never expected by its originators, but to scientific men, whatever be the branch of the subjects to which they give their attention, the collection will be of the highest interest. In its way it is certainly altogether unequalled, and we may presume that the intelligent pleasure of the comparatively small number of visitors will amply compensate its originators for the absence of the classes who have formed the vast majority among the patrons of the former international exhibitions."

The *Daily Telegraph* of Monday writes as follows:—

"By her presence on Saturday at the assembly which has thus hopefully preceded the public opening of the exhibition in the galleries bordering the garden of the Horticultural Society, the Queen stamped with an approval not less enlightened than gracious and kindly the most interesting and valuable scientific display that has ever been organised in this or any country of the world. . . .

"Many discoveries have been and are yet to be achieved by means of instruments exhibited in that grand collection at South Kensington; and we may reasonably infer that had it not been for the invention of certain apparatus the most important natural truths must have remained unknown. In the Loan Exhibition at South Kensington is laid the basis of a Science Museum such as was strongly recommended in the report of the Royal Commission on Scientific Instruction, over which the Duke of Devonshire presided. The Conservatoire des Arts et Métiers in Paris appears to have been the model observed by those most interested in the new scheme; and, the co-operation of foreign countries having been obtained, a collection which illustrates the past struggles as well as the existing triumphs and aspirations of science is now accessible to all who desire instruction of so wide and so elevating a character.

"Though it is utterly impossible within the compass of this notice to indicate a hundredth part of the wonderful attractive collection spread through these five rooms upstairs, we may at least assure all intending visitors that, with catalogue and handbook to guide and assist them, they may employ, to inestimable profit, half a long day in looking at object after object, and will then feel the necessity of another visit. Such a book [the Handbook] is a cyclopædia of useful knowledge in itself. Nor can the admirable arrangement of objects be passed over without praise. The inevitable fatigue of studying attentively a vast scientific museum is reduced as much as possible by the perfection of system and method, in classifying the objects, and in placing them well within view."

The *Engineer* says:—

"Owing to the excellent organisation which was made at an early date, and the support which has been afforded from all quarters, the exhibition seems likely to be even a greater success than was ever dreamt of when it was at first proposed."

Speaking of the Conferences the same journal goes on to say.

"If these lectures and discussions are printed and collected into a volume, as there is some talk of doing, a most valuable addition to scientific literature will without doubt be made, especially if permanent photographs of the chief objects be taken and added to it by way of illustration. The conference room, however, is very small, and a bad shape for such a purpose; and if the meetings are as fully attended as one may expect them to be when lectures are to be delivered by such gentlemen as we have above mentioned in connection with the mechanical section, and by equally eminent ones in other sections, there is every likelihood that it will be found altogether too small and confined, in which case most probably the meeting will adjourn to the arena of the Albert Hall. There can be no doubt that the exhibition and meetings themselves will do much to further science in this country, but it is hoped that still more lasting results will accrue, as was shadowed forth by the Lord President and the Vice-president of the Council on Education, the Duke of Richmond, and Viscount Sandon, at the first meeting of the general committee, who referred to the recommendations of the Royal Commission on Scientific Instruction with regard to the creation of a science museum, and expressed a hope that the loan collection might become the means of developing the educational and other departments of the South Kensington Museum into a similar museum to the Conservatoire des Arts et Métiers in Paris, which would tend to the advancement of science and industrial progress in this country."

Last week's *Iron* speaks of the collection as follows:—

"The success of the Loan Collection of Scientific apparatus, to be inaugurated by the Queen this day (Saturday) is no longer a matter of doubt. The invitations to contribute have been responded to by the scientific world, both at home and abroad, with singular liberality, while the mass of material which has flowed in from all quarters has been dealt with by able and judicious hands. That the opening should have been somewhat delayed seems, too, rather a matter for congratulation than otherwise, as the completeness of the exhibition has been in consequence increased. Of the five sections under which the exhibits are grouped, it is true that some are still inadequately represented; but the very great interest of the physical and mechanical groups more than compensates for any deficiencies under the heads of chemistry, biology, and geology.

"The particular advantage which attaches to this latest modification of the now somewhat discountenanced International Exhibition is, that it brings together apparatus and models which the most attractive World Fair would never have drawn from their retirement. Men of science and students, as a class, are not influenced by the inducements which are most operative with ordinary exhibitors; but none the less is it necessary for the advancement of knowledge that their treasures should be, from time to time, examined and criticised by their fellows.

"There is much of interest in the geological and geographical sections, though nothing very new. Of the metallurgical division—with a miserable dozen exhibits out of a total of nigh on five thousand—what can be said? Is metallurgy devoid of scientific interest? Or has one of the greatest of England's industries no followers who care to do anything for its advancement? With this sole exception, the Science and Art Department must be held to have scored a great success, and to have saved the Government from the reproach of doing nothing for science. It only remains to hope that the magnificent collection which now fills the exhibition galleries will not be dispersed without an effort being made to secure for the nation such portion of it as may be obtainable, and suitable to form the nucleus of a technical and scientific museum, on the plan of the Conservatoire des Arts et Métiers of Paris and the similar institutions to be found in every large German city."

Such is what may be called "lay" opinion upon the importance and success of this unprecedented Collection; and that this opinion is endorsed by that of men of science themselves may be seen from the addresses of Mr. Spottiswoode and Dr. Siemens, which we are able to publish to-day.

THE REMINGTON TYPE-WRITING MACHINE

In making comparison between the physical and the biological sciences, it is not difficult to recognise how it comes that they differ in one essential element. In the *physical* the forces in action are comparatively few, and of very different degrees of intensity. The centripetal and centrifugal tendencies, for instance, of moons and planets so far exceed the mutual attractions of the planets *inter sese*, that in the rough calculations of their orbits the latter may be omitted from consideration.

In the study of the phenomena of life, however, the innumerable forces which are found to be in play are so fairly balanced in their magnitude and tendencies, that the task of dissociating and classifying them is almost beyond the means at the disposal of the human mind.

In the study of the various machines which have from time to time been constructed with the purpose of economising or superseding the employment of the engine—muscle, expensive in the nature of the fuel it requires, although it is so economical in the way in which it uses it, a similar division may be made. In the steam-engine, however developed, the waste of force essential to the working of the valves is nothing in comparison to the power employed, nor in the telegraphic needle is much done by the current except the actual record which it makes.

But on looking at the sewing-machine or the more novel type-printing apparatus we can see that the ingenuity of America, stimulated by the idea of practical advantage, has been developed in a direction, not towards the discovery of more economic principles, but to the employment of forces already known in the mastery of complicated operations previously thought to be beyond the powers of any other mechanism than the hand of man. To obtain these results an entirely different conception has to be introduced. The power at the disposal of the operator has not to be directed simply to the performance of a single operation, like the movement of the needle in the sewing-machine or the impressing of the letter in the type-writer, but has to be distributed so that it may perform a series of simultaneous operations, all leading to a complicated result. The treadle of the sewing-machine in its movement, besides the rise and fall of the needle which it produces, works the thread loop-slip, shifts the fabric, and unwinds the cotton. The pressure on any one of the keys of the type-writer, besides the impression which it stamps upon the paper, shifts that paper, inks the type, and places each letter in its proper sequence.

In order properly to balance all these varied actions, great ingenuity and much practical experiment are necessary, and of the "Remington Type Writer," the only satisfactory instrument of the kind yet brought to public notice, the introducers, the most prominent of whom is Mr. Jefferson M. Clough, superintendent of the Remington Armoury, tells us that "during the time required to perfect the invention, about fifty machines were constructed, all upon the same general principle, but each differing more or less in the minor details."

This general principle is a most ingenious one. It is evident that the great difficulty in the construction of such an instrument is that it is necessary to have a large number of signs—letters of the alphabet, figures, stops, &c., arranged in such a manner that any one of them may, by the simple pressure on a corresponding key-note, be printed in any required order or sequence upon a paper sheet placed ready to receive it. There are many more or less elaborate ways in which this may be accomplished; none, we believe, so simple as that adopted by the Messrs. Remington. Their apparatus may be compared to a piano, even in its details. There is a key-board, on each key of which the letter it impresses is to be found indicated. The depression of each key raises a hammer. This hammer, however, instead of being covered with a felted pad, as in the piano, carries at its extremity a type-cast letter, which, in place of a stretched wire, strikes on a piece of paper the impression of the letter which it bears. So far the similarity between the two instruments is very close. But to produce sounds and to perpetuate impressions in black and white in any definite sequence, are two very different things, the latter being much the more difficult; and herein lies the ingenuity of the principle adopted in the type-writer. The hammers, instead of being arranged in one line, as in the piano, form a circle, in the exact centre of which each type-letter at the end of its hammer-lever strikes upwards. Two keys struck at the same time must consequently cause two type-letters to clash in their attempt to reach the same spot, the centre of the circle. This, however, does no injury to the instrument, although care must be taken not to cause it. Above the circle of levers the recording paper is situated, rolling on a drum, towards the operator, the whole being so placed that just before any letter of a word is struck that part of the

paper on which the letter has to be impressed is nearly over the middle of the lever-circle. The depression of the key first moves the paper into the exact position and then prints the letter, figure, or stop. An independent key produces the blank between each two words.

The method of inking is excellent and unexpected. A strip of fine fabric, saturated with the ink is carried between two rollers so arranged that it intervenes *between* the paper to be printed on and the centre of the lever-circle. The type-carrying hammers do not, therefore, strike the paper itself at all, but only the ink-saturated band, which, as a result of the percussion, comes in contact with the recording paper, *but only in the parts where contact is made*, which are nothing more nor less than those corresponding to the configuration of the letter or figure employed. There is a simple shifting apparatus to carry this inking band from one roller to the other, and afterwards back again, which prevents the same part from being struck too often.

A side lever shifts the paper at the end of each line, and a small bell is struck to warn the operator when this has to be employed.

Into further detail we need scarcely enter. The whole instrument is not larger than a sewing-machine. Its cost is twenty guineas. It only writes in capitals, the total number of keys being forty-four, arranged in four rows of eleven in each. Its simplicity is the best guarantee of its durability.

As to the "typoscript" (in contradistinction to the manuscript of ordinary handwriting), there is no comparison between its clearness and that of average penmanship. It has, in fact, all the appearances of print, with its many advantages as regards legibility, compactness, and neatness. Errors, if detected soon enough, can be corrected by the repetition of the word or sentence, and the subsequent obliteration, upon reperusal, of the faulty lines. The ink employed can be transferred like transfer ink.

The principal question which this beautiful and ingenious little instrument suggests to our minds is, whether it would not be better for every one of us to learn the Morse telegraph language, and employ it for writing upon all occasions instead of the cumbrous letters now in vogue. Thought is more quick than formerly. Germany is rapidly rejecting its archaic type; why should we not go further and write in Morse, where spots and horizontal lines do duty for all necessary signs, and type-writers of the simplest form would be required?

ORIGIN OF LIFE

On Fermentation. By P. Schutzenberger, Director at the Chemical Laboratory at the Sorbonne. With twenty-eight Illustrations. (Henry S. King and Co., 1876.)

Sur la Génération des Ferments. Par E. Fremy, Membre de l'Academie des Sciences, Professeur de Chimie à l'Ecole Polytechnique et au Muséum d'Histoire Naturelle. (G. Masson, Editeur, Libraire de l'Académie de Médecine: 1875.)

Evolution and the Origin of Life. By H. Charlton Bastian, M.A., M.D., F.R.S., Professor of Pathological Anatomy in University College, London. (London Macmillan and Co., 1874.)

THE work on fermentation is one of the International Scientific Series. Starting with a thoroughly philosophical conception of his subject, the author points out that from our present stand-point of knowledge, all those phenomena classed together under the name fermentation, are but special cases of the chemical phenomena of life. To life, however, we are not to attribute any extra-material force or influence. Though the force that can reduce the complex chemical edifice called sugar in a certain determinate direction, is manifested only in the living cell of the ferment, yet this "is a force as material as all those we are accustomed to utilize." "In other words, there is really no chemical vital force. If living cells produce reactions which seem peculiar to themselves, it is because they realise conditions of molecular mechanism which we have not hitherto succeeded in tracing, but which we shall, *without doubt*, be able to discover at some future time." In the book will be found a clear and concise statement of our present knowledge of fermentation, and a brief history of the progress of opinion and research. The outstanding questions (and there are many) and diverse opinions are presented with scientific impartiality, as is also contradictory evidence. It is gratifying to observe how such rival theories as those of Liebig and Pasteur on the nature of fermentation can be swallowed up in a larger conception, and one at least of the combatants conclude that both may be right. "Fermentation," says Liebig, "is a movement communicated by instable bodies in process of chemical transformation." "I maintain," says M. Pasteur, "that the chemical act of fermentation is essentially a phenomenon correlative to a vital act." "So be it," replies Liebig, "'a vital act' is a phenomenon of motion; your special views fall within my theory." Necessarily large space in this work is given to the extensive and splendid researches of M. Pasteur, whose views the author follows in the main, though not at all times able to find them quite self-consistent or consistent with admitted facts. On the great question of most general interest—What is the origin of ferments? he adopts the conclusions of M. Pasteur.

The origin or generation of ferments is the subject of the work by M. Fremy, who has long and ably contested the theory maintained by M. Pasteur. According to this last distinguished chemist, all ferments are the offspring of living things similar to themselves; and when these organisms appear in any liquid, such as milk, or the juice of the grape, it is because the germs or eggs of these creatures have in some way been introduced into the liquid. M. Pasteur has made a great many interesting and most important experiments which to his mind demonstrate the doctrine of panspermism. The demonstration, however, is not universally accepted; and M. Fremy is among those who find it possible to admit the accuracy of most, if not of all, M. Pasteur's experiments without accepting his conclusions, while they in their turn bring forward observations and experiments which they hold to be quite irreconcilable with the hypothesis that ferments are always produced from germs of similar organisms. We can in no way refer to the innumerable experiments; we may, however, try to give in a few words some faint conception of the character of the discussion.

Whence, for instance, come the well-known organisms which appear in the expressed juice of the grape, and are invariably associated with alcoholic fermentation? "From germs that have found access to the liquid," says M. Pasteur. "No," replies M. Fremy, "they are evolved,

as are all ferments, from the substance of the organic medium in which they appear." Now panspermitists have always taken for granted that the air is a vast reservoir of germs, all sorts of which they farther assume are everywhere and at all times being deposited on all solid and liquid substances. In perfect accordance with this opinion it was found that when the must of grapes was boiled to kill any germs that might have already got into it, and kept in a small flask from which the solid particles floating in the air were excluded, no fermentation took place. But, say the supporters of heterogenesis, that may not be because germs could not get in, but because by boiling you killed the vegetative life of the liquid. Well, answers M. Pasteur in triumph, it is all the same if you don't boil it. "Du suc de raisin pris dans l'intérieur du fruit et du sang retiré directement de la circulation se conservent sans altération, si on les préserve de l'influence des poussières atmosphériques. Dans ce cas, on ne peut pas invoquer la mort, par l'ebullition, des substances hémiorganisées vivantes qui existent dans le liquide." This is the fact which to M. Pasteur's mind ought to put an end to the discussion. The readers of NATURE know how he has used it against Dr. Bastian in his letter to Prof. Tyndall (NATURE, vol. xiii. p. 305), and the uninitiated might well look on this as a decisive blow; but the end is not yet. It was suggested long ago that in all experiments of this class the air in contact with the liquids described by Pasteur as "l'air pur, privé de ses poussières flottantes," soon became changed from its normal composition; it loses its oxygen, the presence of which is held to be an essential condition of the development of the alcoholic ferment. But this is not all. If the air contains the germs of the alcoholic ferment, "Why is it," asked M. Fremy very naturally, "that liquids in which this organism propagates and multiplies very rapidly if once introduced do not enter on fermentation when left exposed to the air?" Here is M. Pasteur's remarkable answer: "C'est que cette liqueur s'est couverte de moisissures; la place étant prise par les mycodermes, les ferments n'ont pas pu se développer." One step more. M. Pasteur has elaborately collected the dust from the atmosphere and carefully sown it in various prepared mediums without, however, once succeeding in obtaining alcoholic fermentation, although he sowed this dust in a liquid most suitable for the development of the alcoholic ferment. How has this awkward-looking fact been met by the advocates of the germ theory? Very simply, thus: Well it would appear, they observe, that after all the germs of the alcoholic ferment are not in the atmosphere, but the ferment always comes from germs nevertheless; the germs are on the surface of the grapes themselves. And M. Pasteur is ready with an experiment to prove it. Of course M. Fremy is equally ready with experiments and arguments to prove that it is not so.

Our space will not permit us to pursue the subject further. The morsel of the discussion which we have been able very imperfectly to present may, we hope, enable the general reader to perceive that we are still some way from that settled peace which follows victory. We make no pretence to have stated M. Fremy's case; the subject is intensely interesting, and we heartily recommend his book as a model of scientific discussion. In point of scientific temper he has altogether the advantage of his brilliant antagonist.

The following notice of Dr. Bastian's "Evolution and the Origin of Life" was written and put in proof a long time ago. It would have never been published, but for the fresh interest that Prof. Tyndall has given to the question.

It fell to the writer of this notice to review Dr. Bastian's "Beginnings of Life" (*Examiner*, Aug. 31, Sept. 14 and 28) on its publication in 1872. Our first words were these:—"One after another our ablest scientific workers are bringing the fruits of their labours and dedicating them as it were, humbly, to that profound philosophy of evolution of which Mr. Herbert Spencer may be said to be the prophet. In the work before us Dr. Bastian has attacked the enemies of evolution in what they have hitherto considered the very citadel of their strength. His chief point is that living organisms are evolved out of dead matter, containing neither spore nor germ, nor any such thing." Such was, and remains, our opinion concerning the relation of Dr. Bastian's researches to the theory of evolution.

It is part of the doctrine of evolution that living matter was once at least evolved from dead matter—from dead inorganic matter. Is there, then, or rather ought there to be, any inherent improbability in the supposition that living

Unless the conditions of life-evolution are known, and are known not to exist in the present state of our globe, the probability is surely the other way. Now the essential conditions of the process are, and will certainly remain for a very long time, one of Nature's darkest secrets. Why then do certain evolutionists so obstinately resist the assertion that Archebiosis has actually been known to take place. We cannot enlighten our readers on this point; nobody has ever been able to say why Dr. Bastian must be wrong.

At the same time, in trying to force evolutionists either to accept his conclusions or to stand convicted of inconsistency, Dr. Bastian may perhaps be held guilty of a little straining. Though we believe with Dr. Bastian that life-evolution is an every-day process, still we cannot agree with him that "the existence of such lowest and simplest organisms as the microscope everywhere reveals at the present day, is quite irreconcilable with the position that life-evolution has not occurred since an epoch inconceivably remote in time." To put somewhat strongly the reply of those who do not follow Dr. Bastian to this conclusion, his contention here is not unlike the reasoning of those critics of Mr. Darwin who argue that *if* men have been developed from monkeys there ought now to be no monkeys, for the plain reason that they ought to have all developed into men. The existence of lowest organisms may perhaps be irreconcilable with the position that life-evolution has not occurred since an epoch inconceivably remote in time, when coupled with Dr. Bastian's belief that *in living matter* there is "an internal principle or tendency leading to progressive complexity of development," whereby every living thing is kept constantly on the stretch for an opportunity to spring forward to a more complex structure. But this conception of an inherent principle of organisation, which, we must confess, appears to us rather ill-defined and unscientific, is

not a part of the theory of evolution, and is expressly repudiated by Mr. Spencer and Mr. Darwin. Now, to those who know nothing about a "principle of organisation," there is no difficulty in conceiving lowest organisms remaining lowest organisms through a time indefinitely long. Indeed, what Dr. Bastian teaches concerning his world of Ephemeromorphs makes the conception very easy. "The complexly-interrelated individuals constituting this vast underlying plexus of infusorial and cryptogamic life must," he says, "remain wholly uninfluenced, so far as their form and structure are concerned, by what Mr. Darwin has termed 'Natural Selection.'" Surely it is quite as easy to conceive the mass of these ephemeromorphs going on for ever in an endless round as it is to picture one of them here and there setting out on its course of ascending development. But though Dr. Bastian, after proving his case, may have been somewhat zealous to convince the world and to confound his adversaries, no dispassionate reader of his books can fail to be struck with the simplicity and clearness of the reasoning, and the truly scientific candour of the author.

The complete argument is contained in this book, which may be profitably read by those who have not time to go through the larger work. Since the publication of that work some progress has been made. "Well-informed men of science," says Dr. Bastian, "no longer doubt that swarms of bacteria can be made to appear within sealed glass vessels containing suitable fluids, after the vessels and their contents have been exposed to the temperature of boiling water." That is, Dr. Bastian's experiments, which were at first discredited, have been verified by other workers, some of them with no bias towards a belief in spontaneous generation. But with this fact all well-informed men of science have not accepted Dr. Bastian's conclusion that these living things are evolved from dead matter. Not believing in spontaneous generation, they first supposed that Dr. Bastian must have bungled and deceived himself, because they had every reason to believe that living matter could not resist the temperature of boiling water. They are now obliged to admit that Dr. Bastian was not mistaken. Some, however, admitting this, prefer to give up their well-supported belief in the killing power of boiling water, rather than break with the sacred dogma, *omne vivum ex vivo*, in support of which they can now urge no single fact or argument.

In the treatise before us Dr. Bastian collects a great deal of evidence as to the amount of heat requisite to destroy life, which, summed up, amounts to this: "that all known forms of living matter with which accurate experiment has been made invariably perish at or below 140° F." And he details experiments of his own, in which living organisms appeared "within closed flasks which had been previously heated to 270-275° F. for twenty minutes, and to temperatures of over 230° F. for one hour." Having done this much, Dr. Bastian might, we think, rest satisfied for the present. If his readers fail to appreciate his facts, the little lessons in logic to which he occasionally treats them will not, we fear, help them much. We would also observe that though error may die hard, yet, if he has given it its death-wound, there is no great purpose to be served by triumphing over its last struggles and agonies. "Victorious along the whole line" may now be said of spontaneous generation with much greater truth than it was asserted by Prof. Huxley of the contrary view in 1870. With the facts as they now stand, it appears to us that no adverse criticism can do anything to shake the position which Dr. Bastian has given to the doctrine of the *de novo* origin of life. Some of the attempts that have been made to escape Dr. Bastian's conclusion, after admitting his facts, are curiosities in the way of scientific discussion. Now it is suggested that germs may have been protected from the destroying heat in the inside of enormous lumps almost as large as a pin's head. Again, and still better, that the germs of bacteria may escape death by reason of their excessive smallness. This last is a very happy thought, and deserves to be thoroughly worked out.

In conclusion, we would impress on those of our readers who may take some interest in this question, that there are special reasons why they ought not to rest satisfied with any second-hand statement. If they would know Dr. Bastian's case, they must read his book, which, thinks an American philosopher, Mr. Fiske, "may perhaps mark an epoch in biology hardly less important than that which was inaugurated by Mr. Darwin's 'Origin of Species.'"

Such was the light in which the question presented itself to one who, before studying Dr. Bastian's works, had passively accepted the doctrine *omne vivum ex vivo*. Only when we read Prof. Tyndall's paper of Jan. 13 did we find how far we were mistaken in supposing that the high honour of having settled a great question and added an important truth to our stock of science was about to be awarded to Dr. Bastian by universal consent. Certainly if we are to take Prof. Tyndall—a science teacher for whom we have the highest respect and admiration as our guide and instructor on this subject, we might well blush at the youthful precipitation with which we threw ourselves into the arms of Dr. Bastian. We can only say that we had conscientiously tried to follow the controversy, and to make ourselves acquainted with the alleged and accepted facts. We honestly believed, and still believe, that we were making a simple statement of fact when we said, that Dr. Bastian's experiments, which were at first discredited, have been verified by other workers, some of them with no bias towards a belief in spontaneous generation, and that this was known to "well-informed men of science." When Prof. Tyndall says that he was "certainly not among the number" to whom the truth of Dr. Bastian's assertions was known, the phrase is slightly ambiguous. Of course Prof. Tyndall does not mean that he did not know that Dr. Burdon-Sanderson, for example, had by careful experiment established to his own satisfaction, though contrary to his expectation, that Dr. Bastian was accurate in his statement of fact. That Prof. Tyndall supposed it probable that Dr. Bastian and Dr. Burdon-Sanderson had committed "errors either of preparation or observation," and that he himself, were he to try, might escape such errors, is evidenced by his undertaking the course of experiments which for the present makes the question once more one of evidence. It was in this sense that Prof. Tyndall "did not know;" but in this sense it would have been an impertinence on our part, and even on the part of most "well-informed men of science" "not to know."

One word remains to be said. The question at issue is

of profound biological importance with large practical bearings. It would be a disgrace to science, or rather to scientific men, were the present uncomfortable dead-lock of conflicting evidence to be permitted to remain for any length of time. Prof. Tyndall will, of course, publish descriptions of his experiments in the fullest possible detail; but the interested public have no just balance in which to weigh the accuracy and skill of Prof. Tyndall against that of Dr. Bastian. The high position of our great teachers undoubtedly carries with it certain obligations; and we scarcely think that we ask too much in the interest of science when we venture to suggest that steps should be taken towards the little friendly arrangement necessary for the settlement of the question.

DOUGLAS A. SPALDING

OUR BOOK SHELF

Solid Geometry. By Percival Frost, M.A. Vol. i. pp. 422. (London: Macmillan and Co., 1875.)

THIS excellent treatise is a revised and considerably enlarged second edition of the similar treatise brought out some few years since under the joint editorship of Messrs. Frost and Wolstenholme. The engrossing duties consequent upon Mr. Wolstenholme's holding the post of Professor of Mathematics at Cooper's Hill, have prevented his taking part in the bringing out of the present work. Great additions have been, and are being, made in this subject, as may be inferred from the fact that this first volume consists of 422 octavo pages, and even in this space many modes of treatment are omitted. "We cannot, however," writes Mr. Frost, "in a volume of moderate compass, pretend to include all the dual results to which our equations might give rise, but must confine ourselves to a development of the methods most generally useful."

The author reserves for his second volume "those parts which are chiefly interesting as pure geometry," bringing into the volume before us as much as he could, those parts of the subject which are more especially required by students who take up physical subjects. Prefixed to the text is a full table of contents: indeed both in this work and that by Dr. Salmon on the same subject, the full list reminds us (though drawn up on different principles) of the diagnoses of the natural orders prefixed to text books on the British flora.

The text is written with extreme lucidity, and the difficulties to be met with in its perusal do not arise from the style, but from the inherent difficulty of the matters treated of. In two or three places we come across the phrases "easy to see," p. 154, "not hard to show," p. 157, and the like; of course here they are not intended to cover inability to expound the matter within reasonable compass, but still we think the proof might have been sketched out. When the student is going through the text step by step, he may even be able to work out the process by himself, but it is not so easy when the book is taken up at other times, when the previous steps in the reasoning are not fresh in the mind.

We note in Art. 192 that the elliptic sections are not pointed out; this and the definition of the *radical plane* (§ 166) which reads somewhat curiously to our mind, are the only defects we have been able to detect—we had marked many passages for comment, but all is so carefully done, and the work brought down to the latest discoveries, [illegible] content ourselves with saying that the book is well entitled to a place by the side of Dr. Salmon's treatise. Mr. Frost, it is well known, employs the term "conicoid" for the surface of the second degree, and in the present work he gives his reasons for persisting (as he expresses himself) in retaining the term. We must just cite here the concluding part of his remarks; the surface of the second degree, "well deserves a distinctive name instead of being recognised only by its number, a mode of designation which, I am informed, a convict feels very acutely. Man might be always called a biped, because besides himself there exist a quadruped, an octopus, and a centipede, but, on account of his superiority, it is more complimentary to call him by some special name."

The list of typographical errors is, we believe, very small, and all are easily corrigible by the reader. The appearance of the book leaves nothing to be desired.

Physiologische Methodik: ein Handbuch der Practischen Physiologie. Von Dr. Richard Gscheidlen, Professor an der Universitat zu Breslau. Erste lieferung.

DR. GSCHEIDLEN has undertaken to supply physiological students with a book which undoubtedly they very much need. He proposes to give a detailed and full account of the instruments and methods of practical physiology, and to consider the experimental basis on which our knowledge of the functions of the animal body are founded.

The book is to be published in parts; the first part, which we have before us, treats at considerable length of the measurements of volume, temperature, time, &c. needed in physiology and of the various instruments used in such measurements. It contains also the beginning of a chapter on physiological instruments and methods in general.

Altogether the present part gives good reason to hope that the work, when completed, will not only succeed in its main object of being useful to beginners, but will also be a valuable book of reference in physiological ways and means. We shall, however, reserve detailed criticisms till the book is published as a whole.

J. N. L.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

Periodicity of the Fresh-water Lakes of Australia

THE fresh water lakes of Australia, though insignificant in size in comparison with the extent of the country, possess several features of considerable interest to the naturalist. Lake George, which is generally considered the largest sheet of fresh water on the Continent, is only some twenty-three or twenty-four miles in length and seven miles in breadth at the widest part, and even this lake had no existence twenty-four years ago. A bit of swampy ground across which drays could pass, occupied, in 1852, what is now the lowest part of the lake-bottom, and the rest was taken up by squatters and small farmers, who little dreamed, when they settled on the rich alluvial plain, that within a few years they would be hopelessly driven from their homes by the advancing waters. The present lake is situated, at an elevation of about 2,000 feet above the sea, at the lower end of a shallow basin formed by a fork near the southern extremity of the Blue Mountains, and about 150 miles from Sydney. This basin is some forty to fifty miles in length, and from fifteen to twenty miles in breadth, the mountains rising somewhat rapidly to a height of several hundreds of feet on every side except the south. The depth of the water at the present time is only from 25 to 30 feet, which, considering the extent of land submerged, affords a strong argument in favour of the supposition that the lake existed in past times, and was at least as extensive as it is now. An examination of the banks of the creek which runs into the head of the lake confirmed this hypothesis, and led me to believe that it has at one time been much more extensive than it is at present, for the horizontal layers of alluvial deposit could be traced along either bank at an elevation of 10 or 12 feet above the present lake-surface. This, however, could not have been the case within the last one hundred years—probably not within many hundreds of years—for the present lake is fringed with broad expanses of partially submerged forest trees, that must have attained a growth of more than a century before the waters

overtook them. It may, therefore, I think, be assumed that the lake has never in recent times been so extensive as it is now, but that formerly it was much more so.

It will naturally be asked, What are the causes of its recent rapid growth, and what is likely to be the end of it? Without doubt the chief cause lies in the killing of the trees, which, until lately, covered almost uninterruptedly the whole basin except the lowest portion. The water is thus drained rapidly into the lake, and the surface exposed to evaporation reduced to a minimum. The trees have been destroyed chiefly by the squatter, in order to let in the sun and improve the grass. But another and unexplained cause has been at work during recent years destroying the bush, and the trees have died away mysteriously at the rate of scores, if not hundreds, of acres annually. Grub at the roots or within the bark, the injury done by cattle and sheep, opossums destroying persistently the young shoots, and various other pests, have been set down as the cause, but no explanation has as yet been accepted as satisfactory. It would seem rather as if the trees were suffering from some sickness such as animals are subject to, and many square miles of bush may be cleared away before the disease has spent itself.

Whatever may be the cause, the trees are rapidly disappearing within the drainage area of the lake, and the result will be that with improved drainage and less absorption the lake *must* increase in extent during the next few years, provided the rainfall does not seriously diminish during the same period. Another cause which has probably been at work in enlarging the lake during the last twenty-four years, is an increased rainfall; but the argument on this point is rather drawn from the rapid growth of the lake than from any accurate observation. It has certainly happened once or twice during dry seasons that the lake has fallen a foot or two, but it has always recovered and advanced during the following year, so that its growth may be considered to have been continuous since the year 1852. After the winter of 1874, the lake rose from four to five feet, and during the severe drought of the following summer sank to the extent of from one to two feet, but with the returning rains it recovered its former level. If, up to the present time, the first and wet half of a cycle has been operating, and twenty-five years of deficient rainfall were now to commence, it would still, I think, be unreasonable to expect that the lake would contract very much—say to one half or one quarter its present size. The water that falls at the most distant spot in the basin is carried within a few hours into the lake—in the same manner as in other parts of the country it is carried into the rivers; and the same cause which tends to make the floods of the Hunter and other rivers more violent every year, will prevent Lake George from ever again becoming an insignificant pool. It may be noticed that cloudy summers—not necessarily rainy ones—would have a considerable effect in diminishing evaporation and thereby preventing shrinkage. A prevalence of westerly or northerly winds would have an opposite effect.

Near one of the squatters' houses, long ago submerged, was a well-stocked fish-pond. This the advancing waters soon appropriated, and its occupants finding their way into the lake, have increased to such an extent that the lake itself is now well stocked. These fish were chiefly the freshwater cod of Australian streams, and some of them have thriven so well that it is by no means rare to meet with specimens weighing from thirty to forty pounds each. Black swans, large flocks of three or four different kinds of ducks, with the red legged ibis and other birds frequent the shores and afford good sport.

The general appearance of the lake shore is somewhat desolate on account of the enormous number of partially submerged trees that stand, some of them a mile or more out in the water, and give the lake the appearance of an American river during a flood. The Eastern shore, however, is very beautiful for Australian scenery, the hills dotted with clumps of dark casuarina rising in beautiful grassy slopes from the water's edge.

At a few miles distance from Lake George to the eastward is Lake Bathurst, a much smaller sheet of water that appears to be under very much the same influences as the larger lake, the encroachment of the water being as well marked, although not so extensive.

It would be interesting to know all the influences at work in the increase of the Great Salt Lake, Utah, which is said to be growing at the rate of ten inches in vertical height yearly. As the whole country in the neighbourhood of this lake is destitute of trees, a periodic increase of rainfall is most probably the chief cause, in which case the lake's maximum may be expected to be reached at any time.

The cultivation of land previously bare might naturally be expected to cause a greater retention of moisture, whilst at the same time the hardening of the surface by the treading of cattle and sheep would cause the water to run off more easily; but the area of cultivated or pastured land within the drainage basin compared with that left in its primitive condition, is unknown, and it would be impossible to differentiate their effects.

It will be a subject of considerable interest to watch the conduct of the lakes during the next twenty years. R. ALBAY

The Cruise of the *Argo*

MANY useful suggestions were forwarded to me by the readers of NATURE before the yacht left Liverpool, in return for which I send my best thanks and a list of the places we have visited in the course of our most delightful and, as I trust, not unsuccessful voyage. Jan. 24, Madeira; Feb. 7, Antigua; Feb. 12, Barbuda; Feb. 13, St. Kitts; Feb. 14, Guadeloupe; Feb. 15, Dominica; Feb. 17, Martinique; Feb. 18, St. Vincent; Feb. 20, Grenada; Feb. 22, Trinidad; March 9, La Guayra; March 10, Caracas; March 17, Valentia; March 18, Puerto Caballo; March 21, Curaçao; March 27, Santa Marta; March 29, Savanilla; March 31, Carthagena; April 2, Kingston, Jamaica; April 13, Havana (Museum most creditable). We leave tomorrow for Vera Cruz and the city of Mexico, with the Bahamas, Philadelphia, New York, and Niagara in prospect. We have had a clean bill of health and favourable weather throughout. One of the chief objects proposed by Mr. Cholmondeley in undertaking the voyage was to observe the habits of tropical birds in the west, and to increase his fine collection in the aviaries at Condover. Amongst the very numerous specimens of birds now on board are some that are extremely fine, and such as have rarely been brought to England in a living state.

In marine collecting most has been done in sponges, tunicates, and echinoderms. These, which have been gathered amply and in the rough, will no doubt on examination yield some good microscopic forms, and perhaps a few polyzoa, of which there has been to me a most deplorable scarcity. In botanising, very fair success has been met with in Mosses, Lichens, and Fungi mainly. A few most interesting fungi were collected in the deep forest in Trinidad. Entomology has not been neglected, but the extreme dryness of the season has been unfavourable. Of the eminent men, true students of nature, it has been my good fortune to meet, I must not now attempt to mention even the names. My great obligation to them will I trust find a suitable opportunity for acknowledgment. HENRY H. HIGGINS

Havana, April 10

Recent Discoveries in New Guinea, and Papua or Papooa?

THE ascent for ninety miles of a fine river in the south-east portion of New Guinea in September last, by the mission vessel *Ellengowan* has doubtless before now been made known in England (NATURE, vol. xiii. p. 76).

I expect, during the present year, to leave Samoa on my return to England, and I have some hope that I may take New Guinea on my way to Australia, and visit the mission stations of the London Missionary Society on the south-east coast. If this hope is realised, I shall use every available means to determine what this large quadruped is, which has been tracked in three different parts of the island, if no one else makes the discovery before then.[1]

In concluding this letter, I wish to enter a protest against Dr. A. B. Meyer's orthography of the Malay names of New Guinea and the frizzly-haired portion of its inhabitants. He says (NATURE, vol. ix. p. 77 *note*) "I write Papooa, and not Papua, because the Malays pronounce the word Papooa and not Papua." Surely Dr. Meyer must be aware that the vowel *u* in Malay is pronounced like *oo* in English. As early as 1812 Marsden, in his Malay Grammar (p. 12), gives as examples of the sound of *u* the 'English *oo* in loom and tool.'" It appears to me not only pedantic and unnecessary, but also very objectionable, to make a change at the present time. Perhaps I feel more keenly on this point than most persons, owing to the fact that, with the assistance of a large staff of co-workers in various parts of the Pacific, I have in progress a comparative grammar

[1] It has been recently announced in the *Sydney Herald* that Signor D'Albertis has identified the large bird with the red-necked hornbill, and the droppings as those of the cassowary.—ED.

and dictionary of all the principal Malayo-Polynesian dialects, and am trying to reduce the whole to a uniform system of orthography. S. J. WHITMEE

Samoa, Jan. 3

The Visible Horizon

A POINT of some scientific interest has just been argued in the High Court of Justice. It was contended by the Solicitor-General that the three miles' limit of territorial waters was of modern origin, and by Sir R. Phillimore that it was due to that being the distance a cannon ball would reach from the shore. There can, however, be no doubt that the limit was recognised long before the invention of gunpowder.

Three miles is the distance of the *offing* or visible horizon to a person six feet in height standing on the shore. It is natural to suppose that the early maritime peoples of Europe would lay claim to the sea as far as the eye could reach. This distance they would find by experience was just *three miles*, and it can be proved mathematically to be correct. Measured by this standard—a tall man, usually taken as six feet high—the distance is invariable for all time, places, and peoples; measured by a cannon ball, it is constantly varying, and now ought to be five miles rather than three. The fact that the distance depends on both ocular and mathematical demonstration, and is not subject to improvement in gunnery, is the best explanation of its origin and application. B. G. JENKINS

Dulwich, May 8

Lunar Maps

LOHRMAN'S complete map, three feet in diameter, four sections of which were published in 1824, has been recently engraved by J. A. Barth, of Leipzig, under the supervision of Dr. Schmidt, director of the Athens Observatory, who has contributed a descriptive letterpress.

Schmidt's own map of six French feet diameter, will be issued before the end of the present year, from the *atelier* of the Royal Prussian Staff, the Prussian Government having, with great credit to itself, purchased that incomparable work. It is the result of thirty-four years' labour, and contains about 34,000 craters and an equal number of hills, besides over 350 rills and other objects. The difficulty of noting and correctly mapping this amazing number of lunar formations will be understood by anyone at all acquainted with the subject; and it will be seen that Dr. Schmidt has completed an achievement not surpassed in scientific capability and perseverance. A written text will accompany the map.

It were to be wished that our own countryman, Mr. Birt, could look forward to a similar recognition of his services. His great lunar map, of which we have heard nothing for some time, is on a plan quite different from Schmidt's, to which it would be found, if completed, an invaluable accompaniment by observers of the lunar surface; and it will speak but little for the scientific taste of our country if Mr. Birt's work is allowed finally to collapse for want of appreciation and encouragement.

Millbrook, Tuam, Ireland J. BIRMINGHAM

OUR ASTRONOMICAL

THE STAR-LALANDE 27095 (BOOTES).—Olbers, writing to Bode in July, 1804, respecting his observations of the comet of that year, remarks of Lalande 27095, near the place of which star the comet was situated on March 22: "Ist nicht mehr am Himmel zu finden." It was observed by Lalande as a seventh magnitude, 1795, May 25 ("Histoire Céleste," p. 164), centre wire at 14h. 42m. 10s.

The star was observed by Bessel, 1828, May 24, as a 9th magnitude, and is No. 976 of Hour xiv. in Weisse's second catalogue. In the "Durchmusterung" it is 9·0. There is evidently reason for supposing the star to be variable.

It follows the sixth-magnitude-star B.A.C. 4906, 19s., and is 6′ 37″ north of it, the position for the beginning of the present year being R.A. 14h. 45m. 56s., N.P.D. 52° 6′·5.

THE FIRST COMET OF 1743.—Notwithstanding the very marked deviation of the orbit of this comet from a parabola, it does not appear that any attempt has yet been made to determine, directly from the observations, the true form of the orbit, or at any rate to work out elements which will satisfy the observations within their probable limits of error. It is true that these observations, with one or two exceptions, are by no means exact, and Olbers, who examined the question in 1823, was of opinion that, from their general uncertainty, an investigation into the nature of the conic section described was hardly worth the trouble it would involve. Notwithstanding this expression of opinion from so high an authority, it may be remarked that there are a sufficient number of observations in our possession which cannot fairly be supposed liable to serious errors to justify an attempt to deduce more satisfactory elements than those hitherto calculated.

The comet appears to have been first observed by Grischow or Grisso, at Berlin, on February 10, and his observation on the evening of that day was considered by Olbers to be the most certain of any he made upon this comet, and not liable to a greater error than 2′ or 3′. On February 14, 15, 16 and 19, Grischow, observing apparently with Margareta Kirch, also gives particulars from which probably fair positions might be deduced. And we have an observation by Father Frantz, of Vienna, on February 21, given in proper form in the "Philosophical Transactions" of the Royal Society. Also a good observation by Maraldi at Paris on February 13, and one by Cassini on February 17, which last, however, is open to some doubt, not only for a reason pointed out by Olbers, but from an error as to the comparison star. Zanotti's observations at Bologna, form the longest series, and extend from February 12 to 28, but they are only published (in *Mémoires de l'Académie*, 1743) in longitude and latitude to minutes of arc, without further detail, and were not given by Zanotti as having any pretensions to accuracy. The parabolic orbit with which Olbers was content to discontinue his computations was the following:—

Perihelion Passage, 1743, Jan. 10, at 20h. 29m. 37s. Paris M.T.

Longitude of perihelion .	92 57 51	
,, ,, ascending node .	67 31 57	
Inclination to ecliptic . .	2 10	
Perihelion distance	0·83818	(Earth's mean distance 1)

These elements agree well, according to Olbers, with the positions observed on Feb. 10 and 28, and with the longitudes on Feb. 13 and 21, but the latitudes on these days differ by 14′ and 10′ respectively, which is precisely the kind of discordance, which we might expect to find, if the true orbit of the comet were an ellipse of short period. It will be remembered that Clausen considered this comet identical with that of November 1819, detected by Blanpain at Marseilles, with a period of 6·73 years before 1758 and 5·60 years after 1817, and that at the suggestion of Olbers the perturbations were calculated at the Collegio Romano to the year 1836, when the comet had been expected to re-appear. The orbit of short period which appears in catalogues with Clausen's name, was calculated from Zanotti's observations of Feb. 12, 20, and 28, with a pre-supposition as to the length of the major-axis. As already remarked, no attempt, so far as we know, has yet been made to deduce elements direct from the observations, which shall represent them with smaller errors than the parabolic orbits of Lacaille, Olbers, and Struyck.

Grischow records that on the evening of Feb. 11, 1743, the apparent diameter of the comet was 18′, that it appeared like a greyish-white cloud, but with close attention, "ein kleines helles Punctlein in der Mitte gewahr." We find by calculation that the comet at this time was distant from the earth only 0·051 of the earth's mean distance from the sun, and are reminded that such an object would have afforded an opportunity of the kind to which Mr. Marth has lately adverted, for a determination of the amount of solar parallax. A similar opportunity

may recur at any time, and, as is most probable, very suddenly; we can only hope that observers will be equal to the next occasion.

THE MINOR PLANETS.—Of the members of this group, in addition to the four older ones, Ceres, Pallas, Juno, and Vesta, at present favourably placed for observation, the brighter are Hera, Iris, and Melpomene; Hera and Melpomene are a little below the tenth magnitude, and Iris about 9·5. The following are approximate positions for Greenwich midnight:—

	Hera. R.A.	Hera. N.P.D.	Iris R.A.	Iris N.P.D.	Melpomene. R.A.	Melpomene. N.P.D.
	h. m. s.	° ′	h. m. s.	° ′	h. m. s.	° ′
May 20	16 45 53	104 11	16 56 25	114 5	15 29 27	92 15
„ 24	16 42 20	104 5	16 52 28	113 53	15 25 36	92 3
„ 28	16 38 52	103 59	16 48 22	113 40	15 21 50	91 54
June 1	16 35 15	103 51	16 44 10	113 26	15 18 14	91 45

THE GREENWICH TIME SIGNAL SYSTEM

IN NATURE for April 1 of last year (vol. xi. p. 431) we gave a description of the new Sidereal Standard Clock of the Royal Observatory at Greenwich. Fundamentally important as is this clock in all that concerns its relation to exact astronomical science, it performs also another and more immediately practical duty, that of regulating the time of great part of the United Kingdom. And we propose now to trace the connection existing between this purely astronomical clock and those by which the daily business of our lives is arranged.

A few words of preliminary history may not be uninteresting. Formerly, when, comparatively speaking, little communication existed between the people of different towns, each place kept its own local time. But when railways began to be extended through the country in all directions, such manner of reckoning time could not with any regard to convenience be followed in arranging the movements of trains. The adoption of one uniform system of counting time having, as regards railways, thus become a necessity, all towns in connection with railways, as a matter of convenience, fell sooner or later into the same system, one now universally followed. The time of the meridian of Greenwich is that employed. This selection was probably in part accidental. The railway authorities, when seeking for uniformity, would naturally be led to take as standard the time of the most influential place, and so adopt metropolitan time, which happens to be, practically, Greenwich time. But however this may be, the selection was for another reason a happy one. The meridian of Greenwich is that from which longitudes are counted on all British maps, and Greenwich time having been already long used by the navigator, means of obtaining a proper knowledge of it at seaports was very desirable. Its adoption for railways by facilitating the after-introduction of the time-signal system as now existing was therefore a fortunate circumstance.

The regular exhibition of accurate time for public use, by any kind of authoritative signal, was commenced at Greenwich in the year 1833, when the first time-ball was erected on the eastern turret of the ancient portion of the Observatory buildings, principally for the purpose of giving Greenwich time to chronometer makers and seamen. It has been dropped every day since the year mentioned, excepting only during some periods of repair, and occasionally on days of violent wind. The ball, which is about five feet in diameter and painted black, is by mechanical means raised half-way up its mast at 5 min. before 1h. as a preparatory signal; at 3 min. before 1h. it is hoisted to the summit. It drops at 1h. true Greenwich mean solar time. Formerly it was discharged by an attendant who, watching a clock the error of which had been previously ascertained, pressed the ball-trigger at the proper instant, but since the year 1852 it has been discharged by automatic means, as will be explained further on. The first start of the ball, or its separation from the cross (indicating the cardinal points) immediately above, is very sudden, and is the phase to be noted; afterwards (to avoid injury to the building), a piston, connected by a long rod to the ball, falls into a nearly air-tight cylinder, and so checks its descent that it comes gently to rest at the foot of the mast.

Within a few years of the establishment of the Greenwich ball, others were erected at British observatories near to ports and harbours, as Edinburgh, Liverpool, Glasgow, &c., principally also for the service of shipping. And such signal balls or equivalent means of exhibiting time are now to be found at many observatories abroad, as for instance at the Cape of Good Hope, Madras, Bombay, Sydney, Melbourne, Mauritius, Quebec, Washington, &c. Originally such time-balls could only be dropped at an observatory or institution at which time was determined by celestial observation, but on the introduction of the electric telegraph an observatory could be made the centre of a system from which, by galvanic means, time-balls could be dropped at, or time-signals given to, distant points.

On the first establishment of the electric telegraph in England, the connection of the Royal Observatory with the telegraphic system and its possible application to the daily distribution of time throughout the kingdom soon engaged the attention of the Astronomer Royal, but before things had come to any definite shape, the scheme for laying a submarine cable between England and France was proposed, and active steps taken to carry it out. The progress of this work was watched with interest by astronomers on both sides of the channel, and some of the active members of the Institute of France having expressed their earnest desire to take advantage of the new cable for galvanic determination of the difference of longitude between the Observatories of Paris and Greenwich, the Astronomer Royal became enabled in the year 1852, principally with the assistance of Messrs. E. Clark (of the then existing Electric Telegraph Company) and C. V. Walker (of the South-Eastern Railway Company), to establish the long-desired communications on the English side. The application of the telegraph to the direct determination of longitude will not, however, further concern us at present. As soon as telegraphic connection with the Royal Observatory was complete, the system of transmitting time signals from Greenwich for distribution by the Electric Telegraph Company on their lines was commenced, special apparatus having been for the purpose prepared both at Greenwich and London. This we now proceed to describe.

The Mean Solar Standard Clock of the Royal Observatory, the principal clock of the whole time-signal system, erected in the year 1852 specially for the work, is always kept adjusted as nearly as possible to exact Greenwich mean time. It is a clock of Shepherd's construction, with seconds pendulum, and is maintained in action by galvanic means alone. But it works others sympathetically. The wire which carries the galvanic currents from the pendulum to the electro-magnets to drive the hands is continued, before returning to the battery, to other electro-magnets in connection with the hands of other dials in different parts of the Observatory building, so that the hands on all the dials advance simultaneously, the forward motion of the whole system depending entirely on the one pendulum of the standard clock. Of these various clocks, one is fixed in the boundary-wall of the Observatory; it is daily consulted by great numbers of people, and will be familiar to every visitor to Greenwich Park. Several are placed in the Chronometer Room for use in the daily comparison of the Royal Navy and other chronometers, the difference between the time shown on one of these dials and that of any chronometer giving immediately the error of the chronometer without further calculation. Other dials are to be found in different office rooms in which accurate time is necessary. All these

clocks, including a seconds' relay, *a*, in the accompanying sketch, are *driven* by the galvanic current, but the standard clock further *controls* (by seconds' beats passing to London on a special wire from the seconds' relay) other clocks in London, on a principle, introduced nearly twenty years ago by Mr. R. L. Jones, in which the galvanic force is used, not as the driving power, but as an auxiliary, to keep right clocks already going very nearly right, each by its own motive power. The principle has assumed various practical forms, but that proposed by Mr. Jones is generally employed, and is as follows :—The ordinary bob of the pendulum to be controlled being removed, a horizontal galvanic coil is substituted. At each swing of the pendulum the coil encircles permanent bar magnets fixed to the clock-case, and the galvanic current received at each second from the controlling clock circulates through the wire of the coil. Then (within certain rather wide limits), whether the clock to be controlled tends to lose or gain, the magnetic action produced between the coil and the permanent magnets at the instant of passage of the current so accelerates or retards the pendulum that the clock is maintained in perfect sympathy with the controlling clock.

Thus, at Greenwich various mean-time clocks within the Observatory, and several in London, depend on the one pendulum of the standard clock at Greenwich. But it is a condition that the clocks shall continue to show exact Greenwich time, and as no pendulum will perform with the necessary accuracy for any long period, it becomes essential to provide convenient means of making periodical correction. The plan used at Greenwich is as follows :—To the pendulum of the Mean Solar Standard is attached a slender bar magnet about five inches long, carried parallel to the rod by an arm projecting forwards from it. Immediately below, in a central and vertical position, and supported by the clock-case, is placed a hollow galvanic coil, the accelerating and retarding coil. The lower end of the magnet passes closely over the upper end of the coil. A galvanic current when passed through the coil imparts to it magnetic properties, reversion of the current reversing the direction of its magnetism. If the current be such as to cause attraction between the adjacent ends of the swinging magnet and fixed coil, the pendulum, carrying with it the whole system of clocks, will be accelerated ; an opposite current causing repulsion will conversely produce retardation. The only caution to be observed is that correction must not be made too rapidly, otherwise the controlled clocks,

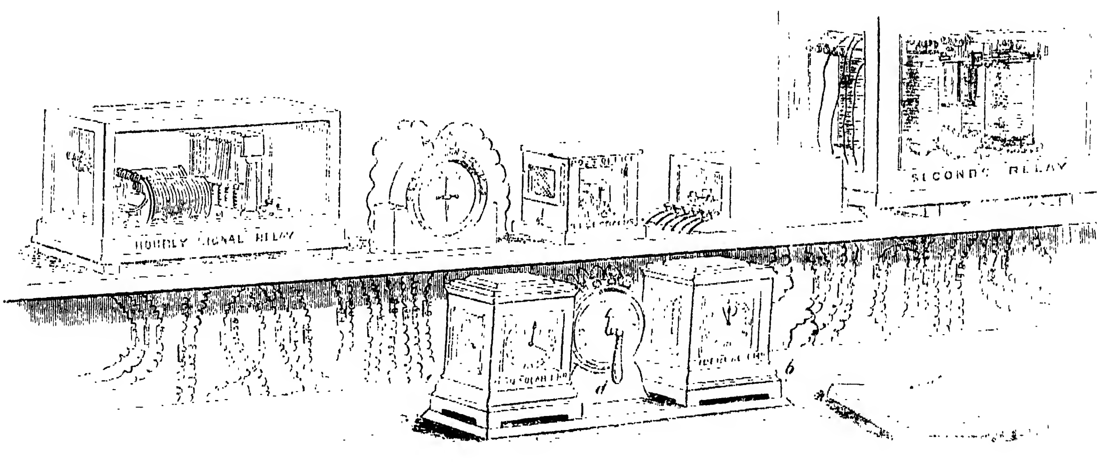

FIG. 1.—Time Signal Apparatus in the Computing Room at the Royal Observatory, Greenwich.

which are, as it were, merely *guided* by the controlling current, might, so to speak, break away from control. As at present arranged, to produce an acceleration or retardation of one second, the current must remain in action for about ten minutes.

Having described the mean-time system of clocks, and the magnetic appliance for correction of accumulated error, we have now to show how at any time the amount of correction required is determined. This makes it necessary to turn our attention to the system of sidereal clocks, and we shall now see how (as was stated at the beginning of this article) the Sidereal Standard is the real timekeeper of the country. This clock, with the system of sidereal clocks in connection therewith, was so fully described in the article already once referred to, that it will only be necessary to repeat here that amongst other things it galvanically registers its seconds on the paper of the revolving cylinder of the chronograph, and drives the sidereal chronometer *b*, situated on a certain desk in the Computing Room. Without going into further explanation it will be understood that, selecting a proper star of the *Nautical Almanac* list, the transit of which over the meridian has been observed with the transit circle and registered on the chronograph the times of its passing the several wires are extracted from the chronograph record, and the mean taken, which being corrected for the small errors of position of the instrument, and also (as the observations are taken by various observers) for "personal equation," the true clock-time of meridian passage, reduced to one standard, is found. The difference between this and the *Nautical Almanac* right ascension of the star for the day gives the error of the sidereal standard, which is also the error of the sidereal chronometer *b*. Unlike the mean-time clocks (which are required always to show true time), the error of the sidereal clocks is allowed to accumulate, and correction applied as necessary in any calculation in which time by one of the sidereal clocks enters.

Near to the sidereal chronometer *b* there is placed, on the same desk in the Computing Room, a mean solar chronometer, *c*, sympathetic with the Mean Solar Standard. Between these chronometers is fixed a commutator, *d*, by means of which a galvanic current can be thrown into the accelerating and retarding coil of the Mean Solar Standard. When the commutator index stands in the position shown in the drawing no action takes place ; when turned to the right the current accelerates the clock ; when turned to the left it retards the clock. To ascertain at any time the

moun[illegible] of correction required, the two chronometers are comp[illegible] by watching for a coincidence of beats [illegible] of the sidereal standard, by astro[illegible] described, the true sidereal time of c[illegible] becomes known the corresponding mean s[illegible] is then easily calculated, and the error of the [illegible] system of clocks immediately found The [illegible] handle is then turned to throw a battery current into the [illegible] and retarding coil, such as will attract or rep[illegible] the pendulum magnet of the Mean So[illegible] Standard according as the clock is found to be [illegible] The Mean Solar Standard and the various clo[illegible] sympathy with it (those driven by it at Green[illegible] and those controlled by it at London) all receive the [illegible] correction, and are all brought to exact Greenwich mean time By the arrangement described it will be seen that the Superintendent of the Time Department can at [illegible] time refer the Mean Solar system of clocks to the [illegible] Standard and find and correct the error of the [illegible] Standard and the whole system of mean [illegible] whilst engaged in his ordinary office duties, and without moving from his position in the Computing Room [illegible] is usually made every morning before [illegible] (because at that hour an important distribution of time [illegible] place), and again before [illegible] (another important [illegible] as regards time signals) The correction required is usually only a small fraction of a second

[illegible] shown how the error of the Sidereal Standard [illegible] is found by astronomical observation [illegible] the Mean [illegible] Standard, and [illegible] time, [illegible] proceed to describe the arrangements for giving time signals to the external world [illegible] circuit [illegible] through the Mean Solar Standard, but is broken in the clock in two places, one of these is united from about half a minute before to about half a minute after the minute hand marks sixty, and the other when [illegible] hand indicates sixty seconds precisely Both [illegible] therefore only be together united at the com[illegible] each hour, and then only can a current [illegible] hourly current [illegible] two electro[illegible] automatically discharges the Green[illegible] the other is [illegible] hourly signal relay (shown to the left in the [illegible] which completes various independent circuits, each [illegible] separate line of wire One of th[illegible] communication with the central telegraph [illegible] General Post Office, London another [illegible] to the London Bridge Station of the South [illegible] Company Along each line [illegible] time [illegible] Observatory [illegible] the control [illegible] point (excepting in the case [illegible] the sp[illegible] terminates The small [illegible] in the drawing marked [illegible] Hourly [illegible] Observatory, the position of the [illegible]

(To be continued)

THE OPENING OF THE LOAN COLLECTION

THE Loan Collection was auspiciously opened on [illegible] the visit of the Queen, and that [illegible] sufficiently shown [illegible] press, which we have [illegible] Queen's visit [illegible] complete su[illegible] Empress of Germany, [illegible] who accom[illegible] interest in the collec[illegible] and especially in those apparatus to which their attention was particularly drawn The *Times* is "authorised to say that not only did her Majesty express to the Lord President of the Council, the Duke of Richmond, her gratification with the exhibition and with its success —exceeding any that could possibly have been antici pated of it—but that her Majesty desired to make known how much she was gratified by the manner of her reception and by the solicitude with which her visit was made interesting by the several scientific men who explained to her the nature of the objects exhibited"

Besides the German Empress, the Queen was accompanied by the Princess Beatrice, the Duke of Edinburgh, the Duke of Cambridge, Prince Edward of Saxe Weimar, and among others who accompanied the Royal party during their tour round the collection were the Duke of Sutherland, the German, Austrian, Russian, and French and Spanish Ambassadors, the Italian Minister, the United States Chargé d'Affaires, besides a considerable number of the most eminent representatives of British and Foreign science, most of the members of the several committees, and many of the exhibitors

The Queen was received at the south eastern entrance to the Exhibition by the Duke of Richmond and Gordon and the Vice President of the Committee of Council on Education, Lord Sandon, M P, by the Commissioners of the Exhibition of 1851 upon whose premises the Exhibition is held, and by the members of the Duke of Devonshire's Committee on Scientific Instruction

The Duke of Richmond and Gordon escorted the Queen round the Exhibition, pointing out objects of interest, and as the Queen entered each division of the galleries, gentlemen conversant with the various branches of science had the honour of being presented and of explaining to their Majesties and Highnesses the objects exhibited

The Educational Collection was first examined, M Heard showing the curious and extensive Russian pedagogical collection In the Mechanical Section the famous primitive locomotives "Puffing Billy" and the "Rocket" attracted considerable attention In this section also the ship *Faraday* was described by Dr C W Siemens, who at the same time explained his bathometer, recently described in NATURE The German ironclad, *König Wilhelm*, and other beautiful models illustrating the applications of science to shipbuilding, including a model of the *Serapis*, were described by Mr E J Reed and the Duke of Edinburgh In this same section Mr W Froude showed his models of the hulls of ships in solid paraffin, by which the valuable experiments were made which were recently described by him at length in NATURE Prof Tyndall's explanation of the lighthouses and fog horns excited considerable interest the Siren fog horn being sounded to illustrate the usefulness of the signal In the Fish Museum Mr Frank Buckland was ready to explain the many interesting objects and processes shown there As the party passed into the gallery of Electricity and Magnetism, the enharmonic organ of Peronnet Thomson was heard from above playing "God save the Queen" In the section just mentioned M Breguet, of Paris, gave a brilliant display of the electric light, while Prof Carey Foster explained the great Haarlem natural magnet Mr Gramme's magneto electric machines were shown by Mr Spottiswoode, and various telegraphic instruments by Mr Culley As her Majesty proceeded leisurely through the collection, Sir William Thomson showed his wonderfully ingenious tide calculating machine, Joule's apparatus for researches in heat, and an apparatus for deep sea soundings Prof Kennedy exhibited the important collection of kinematic models sent by Prof. Reuleaux, of the Royal Technical Academy, Berlin. The Wilter type composing machine was explained by Mr J C Macdonald, Sir Joseph Whitworth described his millionth of an inch measuring apparatus, while Mr Chisholm explained various standard measures, a fine collection of standards made for the Russian Govern

ment by Dr. Werner Siemens, being particularly observed. The Astronomer Royal, Sir George Airy, showed the telescopes of Sir W. Herschel and Lord Rosse, and a little telescope of Newton's.

Prof. Eccher exhibited some interesting memorials of Galileo, his bust, telescope with broken lens, and other objects, invaluable relics, which the Queen expressed her gratification to see generously confided to the care of this Department of her Government by Signor Peruzzi, the Syndic, and the City of Florence. Mr. John Evans, in the Geological Department, exhibited results of the Sub-Wealden boring; and in the spacious gallery and conference room devoted on Saturday to Geography, Sir Henry Rawlinson showed the Queen Livingstone's maps, and illustrated the route of Lieut. Cameron; Lieut. Cameron himself exhibited his charts of the interior of Africa. Capt. Evans, the Hydrographer of the Navy, showed the original logs of Captain Cook and the log of the *Bounty*, and Admiral Ommanney a log of Sir John Franklin. A collection of German maps, explained by Major von Vistinghoff, and the interesting collection of fossil leaves shown by Baron von Ettinghausen, of Graetz were also inspected. In the Biological Department Prof. Burdon Sanderson and Dr. Lauder Brunton showed Marey's and other apparatus for recording and registering vital motion, and the instrument of Prof. Donders, of Utrecht, for measuring the velocity of thought. The musical instruments explained by Mr. J. Baillie Hamilton naturally attracted much attention. The other objects which attracted the attention of and were explained to the Queen and her party were Dalton's apparatus by Prof. Roscoe, Cavendish's and Black's balances by Dr. Frankland, early photographs by Capt. Abney, Russian heliographic plates and engravings by Baron von Wrangell, spectroscopes and radiometers by Prof. Guthrie, Otto von Guericke's air-pump and the Magdeburg hemispheres by Prof. Clerk Maxwell.

Before leaving the galleries, a telegram was despatched through one of the Morse instruments exhibited by our Post Office by the Empress Augusta of Germany, in the name of the Queen and herself, to the German Emperor in the following words: "The Queen and the Empress have passed through the collection at the Exhibition of Scientific Apparatus and have been very much interested." Her Majesty the Queen desired that the same intelligence should be communicated to her eldest daughter the Crown Princess.

To quote the *Daily News*:

"Throughout the course of the long promenade from the south-eastern entrance of the building in Exhibition-road to the exit in the Prince Albert's-road, neither the Queen nor the Empress of Germany exhibited the slightest sign of physical or mental fatigue. On the contrary, their majesties seemed rather inclined to remain for a space in converse with the learned expositors than to treat the inspection as a matter of ceremony."

During the visit, Sir Francis Sandford, Major Donnelly, Mr. Cunliffe Owen, and Mr. Norman Lockyer, were specially introduced to the Queen and Empress.

The Collection was opened to the public on Monday, and the number of visitors has been much greater than most people expected. They belong to all classes, and inspect the apparatus with evident interest and intelligence. The galleries, indeed, bear quite a lively aspect, and there is little danger of the Collection being a failure for lack of a public. We have no doubt, as its value and nature become known, the number of visitors will largely increase.

The first of the Conferences in connection with the Collection was opened on Tuesday, Lord Sandon making a short address of welcome.

"I have come down," he said, "to express my gratitude, and that of Her Majesty's Government, to the different men of science who are the real authors of what I may call the present success. I have had means of knowing personally the extraordinary sacrifices of time and labour of those men of science in this country who have produced the success. It is gratifying, if only for one reason—it has shown what a feeling of intellectual brotherhood exists. We have had the highest men of science of this kingdom working together to produce this very remarkable exhibition. When we think of their zeal and self-sacrifice and determination, the country cannot be too grateful. And these qualities have not been confined to this country, but far beyond this island. It has been a matter of universal remark, the zeal, the determination, and friendly feeling which have been shown by men of science all over the world. We have—the Lord President and myself—done all that we could do to make this not a gazing place merely, but to give as much instruction as possible to those who desire to receive it. These Conferences will be a source of the greatest possible gratification, old friendships will be renewed, new friendships will be created between men of science of other parts of the world. These Conferences will, we trust, be much appreciated. The examination of the collections will be much assisted by the admirable handbooks which have been prepared by men of the highest capacity. Allow me also to express my sense of the very high service which the officers of the Science Department have rendered; their zeal, their highly cultivated intelligence, devotion of time and almost of health—we have reason to be proud of serving the Queen in concert with such officers. To the different men of science I express my hearty good wishes for exertions towards the continued success of the Exhibition. When those Conferences come to a close we shall feel that a great work has been done on behalf, not of this country only, but for the whole of the world."

Mr. Spottiswoode, the President of the Section of Physics, to which Tuesday was devoted, then delivered his inaugural address, which we are glad to be able to give below, as also that of Dr. C. W. Siemens, the President of the Section of Mechanics, which met on Wednesday. The other addresses on Monday were by Mr. W. Huggins, D.C.L., F.R.S., on the present state of Spectroscopic research relating to the Stars and Nebulæ; Mr Norman Lockyer, F.R.S., and Capt. W. de W. Abney, R.E., on Spectroscopic Research in Solar and Molecular Physics; M. le Professeur Soret, on a Spectroscope with a fluorescent eye-piece; Prof. R. Bellamy Clifton, M.A., F.R.S., on Interference, and Instruments for the measurement of Optical Wave Lengths; Mr. H. C. Sorby, F.R.S., on the original form of the Spectrum-microscope, and the various subsequent improvements, and additional apparatus; the Earl of Rosse, D.C.L., F.R.S, on Zollner's Photometer; Prof. Sir W. Thomson, LL.D., F.R.S., on the principles of Compass Correction in Iron Ships; M. Sarasin-Diodati, on De la Rive's Researches in Statical Electricity; and the President, on some recent forms of Polariscopic Apparatus.

In the Section of Mechanics, which met yesterday, besides the address of the President, Dr. Siemens, the following papers were read:—

Sir Joseph Whitworth, Bart., F.R.S., on Linear Measure; Mr. C. W. Merrifield, F.R.S., on Solid Measurement; followed by a communication from Prof. Tilser (Bohemian Institute, Prague); Prof. Sir W. Thomson, LL.D., F.R.S., on Electrical Measurements; M. Tresca (Sous-Directeur du Conservatoire des Arts et Métiers, Paris), on Flow of Solids; Prof. Kennedy, on Kinematics, &c.

The Chemical Section meets to-day, when, after the address of the President, Prof. Frankland, the following papers will be read:

Dr. J. H. Gilbert, F.R.S, on some points in connection with Vegetation; Mr. W. F. Donkin, M.A., of Keble College, Oxford, on the Ozone Apparatus of Sir B. Brodie, Bart., F.R.S.; Mr. A. Fletcher, H. M. Inspector of Alkali Works, on the Gases discharged from Alkali Works; Professor Andrews, F.R.S., Experiments on Gases.

On the 19th and 24th the Section of Physics will again meet; Mechanics on the 22nd and 25th; Chemistry on the 23rd; Biology on the 26th and 29th; and Physical Geography, Geology, Mineralogy, and Meteorology on May 30 and June 1 and 2.

The following are the arrangements which have been made in the Section of Mechanics:—22nd May.—Mr. Barnaby, C.B., Director of Naval Construction to the Admiralty, Naval Architecture; Mr. W. Froude, M.A., F.R.S., Fluid Resistance; Mr. Thomas Stevenson, Lighthouses. 25th May.—Mr. F. J. Bramwell, F.R.S., Prime Movers; Mr. Hackney, B.Sc., Furnaces; Général Morin, Directeur du Conservatoire des Arts et Métiers, Paris, Ventilation; Professor Zetzsche, Electric Telegraphs.

A general idea of the arrangements in other sections will be obtained from the list in last week's NATURE, p. 34.

Besides these Sectional Meetings, several *soirées* have been arranged, the first of which, that of Physics, took place last night. A Geographical *soirée* will be held on Saturday night.

Several visits have, moreover, we believe, been arranged, including one to H. M. S. *Challenger*, which is expected home every day.

The following are the names of some of the distinguished foreigners who have come to London in connection with the Loan Collection:—*Germany:* Dr. R. Schone, Herr Wilhelm Kirchner, Dr. Biedermann, Dr. Neumayer, W. Verners, C. Desaga, Herr Lingke, M. Borus, Dr. Julius Fettbach, Dr. H. Rohrbeck.—*Russia:* Baron von M. Wrangell, M. Heard, Dr. Selim Lemström, Capt. M. Rkeman, R.A., M Ovsiannikow, Prof. A. von Oettingen. —*Italy:* Il Com. Blaserna, Prof. De Eccher, Cav Meucci. —*Austria:* Baron von Ettinghausen, Dr. Albert von Ettinghausen, Dr. Leopold Pfaundler.—*Holland:* Prof. Dr. P. L. Rijke, Dr. J. W. Gunning, Dr. D. de Loos, Prof. Dr. J. Bosscha.—*Switzerland:* M. Soret, M. Hagenbach, M. Forel, M. Wartmann, Prof. Favre, M. E. Gautier, M. Th. Turrettini, M. E. Sarasin, Prof. E. Hagenbach-Bischoff, M. R. Pictet.—*Belgium:* A. Renard, Prof. C. de la Vallée Poussin, Prof. G. Dewalque.—*Spain:* Señor Juan E. Riaño,.—*Orange Free State:* His Honour, the President of the Orange Free State.—*France:* M. Tresca, M. Golaz, M. Breguet, P. Jablochkoff.—*Norway:* Prof. P. Waage.—*Sweden:* Dr. Christian Lovén.

SECTION—PHYSICS.

Opening Address by W. Spottiswoode, F.R.S., &c.

THE opening of this Exhibition may prove an epoch in the science of Great Britain. We find here collected, for the first time within the walls of one building, a large number of the most remarkable instruments, gathered from all parts of the civilised world, and from almost every period of scientific research. These instruments, it must be remembered, are not merely masterpieces of constructive skill, but are the visible expression of the penetrative thought, the mechanical equivalent of the intellectual processes of the great minds whose outcome they are.

There have been in former years, both in this country and elsewhere, exhibitions including some of the then newest inventions of the day; but none have been so exclusively devoted to scientific objects, nor any so extensive in their range as this. There exist in most seats of learning museums of instruments accumulated from the laboratories in which the professors have worked; but these are, by their very nature, confined to local traditions. The present one is, I believe, the first serious, or at all events the first successful, attempt at a cosmopolitan collection.

To mention only a few, among the many foreign institutions which have contributed to this undertaking, we are especially indebted to the authorities of the Conservatoire des Arts et Métiers of Paris, the Physical Museum of Leyden, the Tayler Foundation of Haarlem, the Royal Museum of Berlin, the Physical Observatory of St. Petersburgh, the Tribune of Florence, and the University of Rome.

Among those in our own country, we have to thank the Royal Society, the Royal Institution, the Ordnance Survey, the Post Office, the Royal Mint, the Kew Observatory, besides various other institutions and colleges, which have freely contributed their quota.

To enumerate even the chief of the individual instruments of historical interest would be a task beyond the limits both of my powers and of your patience. But I cannot refrain from naming as especially worth notice among the astronomical treasures, a quadrant of Tycho Brahé, telescopes of Galileo, a telescope of Newton, some lenses by Huygens, one of Sir W. Herschel's grinding machines for specula, and a telescope made by himself in intervals between his music lessons during his early days at Bath, at a time when, to use her own words, his sister Caroline "was continually obliged to feed him by putting victuals by bits into his mouth." This also is probably the "mirror from which he did not take his hands for sixteen hours together," and with which he may have seen for the first time the Georgium Sidus. To come to later days, we have the original siderostat of Foucault, lent from the Observatory of Paris, a compound speculum by the late Lord Rosse, the photoheliograph from Kew, and from still more recent times a complete transit of Venus equipment, from the Royal Observatory at Greenwich.

Turning to other branches of physics, we have a "composed microscope," now nearly three centuries old, constructed in 1590 by one Zacharias Janssen, a spectacle-maker, possibly a connection, or at all events a worthy predecessor, of M. Janssen, the celebrated astronomical spectroscopist. We have an air-pump, and two "Magdeburg hemispheres," with the original rope traces by which horses were attached in the presence of the Emperor Charles V., in order, if possible, to tear them asunder, when exhausted by the air-pump. We have the air-pump of Boyle, the compressor of Pappin, Regnault's apparatus for determining the specific heat of gases, Dumas's globe for the determination of vapour densities, Fizeau and Foucault's original revolving mirrors and toothed wheels, whereby the velocity of light was first determined independently of astronomical aid, Daguerre's first photograph on glass, and the earliest astronomical photographs ever taken. To these may be added De la Rive's instruments for statical electricity; the actual table and appurtenances at which Ampère worked; and some contrivances as if fresh from the hands of Faraday himself.

Yet rich as is this part of our collection, and interesting as it might be made in the hands of one versed in the history and anecdote of the past, we must not linger even about these pleasant places. Indeed a museum of only the past, venerable though it might be, would be also grey with the melancholy of departing life. For science should be living, instinct with vigour and organic growth. Without a continuance into the present, and a promise for the future, it would be like a tree whose branches are broken, whose growth is stopped, and whose sap is dried. And if I may carry the simile a stage further, an exhibition of the present, with no elements of the past, would be like the gathered fruits to be found in the market-place, ready to hand, it is true, but artificially arranged. But when past and present are represented in combination, as has been attempted here, the very newest achievements will be found in their natural places as ripened and ever-ripening fruit in the garden from whence they have sprung.

In reviewing the series of ancient, or at least now disused, instruments, one thing can hardly fail to strike the attention of those who are accustomed to the use of the

modern forms. It is this—how much our predecessors managed to achieve with the limited means at their disposal. If we compare the magnificent telescopes, the exquisite clockwork, the multiplicity of optical appliances, now to be found in almost every private, and still more in every public, observatory, with those of two centuries past; or, again, if we look at the instruments with which Arago and Brewster made their magnificent discoveries in polarised light, in contrast to those with which the adjoining room is literally teeming, we may well pause to reflect how much of their discoveries was due to the men themselves, and how comparatively little to the instruments at their command.

And yet we must not measure either the men or their results by this standard alone. The character of the problems which nature propounds, or which our predecessors leave as a legacy to our generation, varies greatly from time to time. First, we have some great striking question, the very conception and statement of which demands the very highest powers of the human mind; unless, indeed, the clear and distinct statement of every problem may be regarded as the first and most important step towards its solution. Next follow the first outlines of the solution sketched in bold outline by some master hand; afterwards, the careful and often tedious working out of the details of the problem, the numerical evaluation of the constants involved, and the reduction of all the quantities to strict measurement. It is in this part of the business that the more elaborate instruments are especially required. It is for bringing small differences to actual measurement, for detecting quantities otherwise inappreciable, that the complex refinements with which we are here surrounded become of the first importance. But happily this somewhat overwhelming complication is not of perennial growth, for, curiously enough, by a kind of natural compensation, it relieves itself. In reviewing from time to time the various aspects of a problem in connection with the instrumental appliances designed for its solution, the essential features come out by degrees more strongly in relief. One by one the unimportant parts are cast aside, and the apparatus becomes reduced to its essential elements. This simplification of parts, this cutting off of redundancies, must not, however, be understood as detracting from the merit of the original devisors of the instruments so simplified; the first grand requisite is to effect what is necessary for the solution of the problem, then follows the question whether it can be done more simply or by some better process.

And this leads me in the next place to advert for a moment to the advantages which may accrue to the cultivators of science, and through them to the nation at large, from a national collection of scientific apparatus. Through the liberality of our foreign neighbours, and through the exertions of our own countrymen, we have here a magnificent specimen, an almost ideal exemplar, of what such a collection may be. By bringing together in one place, and by rendering accessible to men of science generally, the instrumental treasures already accumulated, and constantly accumulating, we should not only portray in, as it were, living colours the history of science, we should not only be paying just tribute to the memory of the great men who have gone before us, but we should afford opportunities of reverting to old lines of thought, of repeating with the identical instruments important but half-forgotten experiments, of weaving together threads of scattered researches, which could otherwise be taken up again only with difficulty, and after an expenditure of much and irretrievable time.

Let me now turn for a moment to the other side of the picture. If the collection in the midst of which we are here assembled is an evidence of the valuable relics which still remain to us of the great men who have passed away, the circumstances under which some of them have found their way hither, and the vacant places due to the absence of others, are no less evidence of how much the preservation of such objects would be promoted by the establishment of a museum such as I have ventured to suggest. Many circumstances contribute to thrust into oblivion, or to put absolutely out of reach of future recovery, original apparatus. First, the paramount importance and immediate uses of an improved instrument or a new invention; next, in Government departments such as the Survey, the Post Office, &c., the imperative demands of the public service, which leave little or no time for a retrospect of the past; and if I may add a word from the experience of private individuals, the pressing calls of space and expense lead the possessors to throw away, or to utilise, by conversion of the materials to new purposes, apparatus which has done its work. I venture to particularise one or two considerations, which will probably have occurred to many of you, but which appear to me to illustrate the above remarks. In the case of the Ordnance Survey it is almost certain that the current work of the department would never have required, and it is doubtful whether any private interposition would have brought about, the removal of the disused instruments, here exhibited, from the cellars at Southampton. Again, the Post Office would hardly have been justified in devoting valuable time to the arrangement, or valuable space to the storage, of instruments no longer on active service, except at the call of a public department, or for a public purpose. And surely it would be a matter of serious regret that the time already spent upon the collection now before us should have no issue beyond the purposes of the present exhibition. To take another instance; we have here fragments, but only fragments, of Baily's apparatus for repeating Cavendish's experiments; but of Cavendish's own apparatus we have simply nothing. Again, Wheatstone's instrumental remains must inevitably have been broken up and scattered or destroyed, if there had not been found at King's College a resting-place, and authorities intelligent enough to appreciate and willing to receive them. Of other individuals from whom apparatus, now of historical interest, has been received, some from sheer lack of space have been breaking up old instruments, while others, from a modesty commendable in itself, were with difficulty persuaded of, and even now are only beginning to perceive, the value, in a national and cosmopolitan point of view, of their own contributions. Lastly, there is, I think, little doubt but that, if the objects in question were to go a-begging, they would be gladly received in some of the foreign museums which have so liberally contributed on the present occasion.

To put the suggestion in a more tangible form I would venture to suggest that, in the first instance, instruments whose immediate use has gone by, but which are nevertheless of historical interest, lent either by public departments or by private individuals, might remain here on permanent loan; further, that other instruments as they pass out of active service, for example, from the Admiralty, from the Board of Trade, from the Ordnance Survey, or from the other departments, should similarly find a place in this museum. In such a category also might be included the scientific outfit of the *Challenger*, and of the Arctic Expeditions, and likewise those of expeditions for the observations of the transit of Venus or of solar eclipses. To these might be added apparatus purchased for special investigations through the parliamentary grant annually administered by the Royal Society. And further if, as I would suggest, this deposit of instruments be made without alienation of ownership, then private societies or even individuals might be glad to avail themselves of such a depository of instruments not actually in use.

In making such a suggestion, it must of course be assumed that the custody of property so valuable in itself, and so delicate in its nature, would be confided to a

curator thoroughly competent for such a charge, but I abstain from entering prematurely into further details.

And now let me turn in conclusion to one more aspect of this great undertaking. We have here collected not only the instruments which represent the most advanced posts of modern science, but we have not a few of the men whose genius and perseverance have led the way thither; men who stand in the forefront of our battle against ignorance and prejudice and against the host of evils which a better scientific education must certainly dispel; we have men whose powers are competent for, and whose very presence is an inspiration to, further progress. But, while taking this first opportunity of offering them a hearty welcome, I shall however best consult both their feelings and your wishes by abstaining from any panegyric upon them in their presence, and by giving them an opportunity of speaking, and you of hearing them, upon some of their own subjects in illustration of the remarkable instruments which they have with so much pains and trouble brought under our view.

SECTION—MECHANICS.

Opening Address by Dr. C. W. Siemens, F.R.S.

In opening the proceedings of the Conferences regarding Mechanical Science, it behoves me to draw attention to the lines of demarcation which separate us from other branches of natural science represented in this Exhibition.

In the Department of Applied Science we have collected here apparatus of vast historical interest, including the original steam cylinder constructed by Papin in 1690, the earliest steam-engines by Savery and by James Watt, the famous locomotive engine the "Rocket," by which George Stephenson achieved his early triumphs, as well as Bell's original marine engine, and a variety of models illustrative of the progress of hydraulic engineering and of machinery for the production of textile fabrics. In close proximity to these we find a collection of models illustrative of the remarkable advance in naval architecture which distinguishes the present day.

It would be impossible to deny the intrinsic interest attaching to such a collection or its intimate connection with the progress of pure science; for how could science have progressed at the rate evidenced in every branch of this Exhibition, but for the great power given to man through the mechanical inventions just referred to. Yet were Mechanical Science at these Conferences to be limited to the objects exhibited in the South Gallery (and separated unfortunately from apparatus representing physical science by lengthy corridors filled with objects of natural history), we should hardly find material worthy to occupy the time set apart for us. But, thanks to the progress of opinion in recent days, the barrier between pure and applied science may be considered as having no longer any existence in fact. We see around us practitioners, to whom seats of honour in the great academies and associations for the advancement of pure science are not withheld, and men who, having commenced with the cultivation of pure science, think it no longer a degradation to follow up its application to useful ends.

The geographical separation between applied science and physical science just referred to, must therefore be regarded only as accidental, and the subjects to be discussed in our section comprise a large proportion of the objects to be found within the rooms assigned more particularly to physics and chemistry. Thus all measuring instruments, geometric and kinematic apparatus, have been specially included within our range, and other objects such as telegraphic instruments, belong naturally to our domain.

With these accessions, mechanical science represents a vast field for discussion at these conferences, a field so vast indeed that it would have been impossible to discuss separately the merits of even the more remarkable of the exhibits belonging to it. It was necessary to combine exhibits of similar nature into subdivisions, and the Committee have asked gentlemen eminently acquainted with these branches to address you upon them in a comprehensive manner.

Thus they have secured the co-operation of Mr. Barnaby, the Director of Construction of the Navy, to address you on the subject of Naval Architecture, and of Mr. Froude to enlarge upon the subject of fluid resistance, upon which he has such an undoubted right to speak authoritatively. Mr. Thomas Stevenson, the Engineer of the Northern Lighthouses, will describe the modern arrangements of Dioptric lights, which mark a great progress in the art of lighting up our coasts. Mr. Bramwell has undertaken the important task of addressing you on the subject of Prime Movers, and Prof. Kennedy upon the kinematic apparatus forwarded by Prof. Reuleaux, of Berlin. M. Tresca will bring before us his interesting subject, the flow of solids. Mr. William Hackney will address you upon the application of heat to furnaces, for which he is well qualified both by his theoretical and practical knowledge. Mr. R. S. Culley, Chief Engineer of the Postal Telegraphs, will refer you to a most complete and interesting historical collection of instruments, revealing the rapid and surprising growth of the electric telegraph.

Measurement.—Regarding the question of measurement, this constitutes perhaps the largest and most varied subject in connection with the present Loan Exhibition. In mechanical science, accurate measurement is of such obvious importance, that no argument is needed to recommend the subject to your careful consideration. But it is not perhaps as generally admitted, that accurate measurement occupies a very important position with regard to science itself, and that many of the most brilliant discoveries may be traced back to the mechanical art of measuring. In support of this view I may here quote some pregnant remarks made by Sir William Thomson in his inaugural address delivered in 1871 to the members of the British Association, in which he says—"Accurate and minute measurement seems to the non-scientific imagination, a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient long-continued labour in the minute sifting of numerical results. The popular idea of Newton's grand discovery is that the theory of gravitation flashed upon his mind, and so the discovery was made. It was by a long train of mathemetical calculation, founded on results accumulated through prodigious toil of practical astronomers, that Newton first demonstrated the forces urging the planets towards the sun, determined the magnitude of those forces, and discovered that a force following the same law of variation with distance urges the moon towards the earth. *Then* first, we may suppose, came to him the idea of the *universality of gravitation;* but when he attempted to compare the magnitude of the force on the moon with the magnitude of the force of gravitation of a heavy body of equal mass at the earth's surface, he did not find the agreement which the law he was discovering required. Not for years after would he publish his discovery as made. It is recounted that, being present at a meeting of the Royal Society, he heard a paper read, describing geodesic measurement by Picard, which led to a serious correction of the previously accepted estimate of the earth's radius. This was what Newton required; he went home with the result, and commenced his calculations, but felt so much agitated, that he handed over the arithmetical work to a friend; then (and not when, sitting in a garden he saw an apple fall) did he ascertain that gravitation keeps the moon in her orbit.

Faraday's discovery of specific inductive capacity, which inaugurated *the* new philosophy, tending to discard

action at a distance, was the result of minute and accurate measurement of electric forces.

Joule's discovery of thermo-dynamic law, through the regions of electro-chemistry, electro-magnetism, and elasticity of gases, was based on a delicacy of thermometry which seemed impossible to some of the most distinguished chemists of the day.

Andrews's discovery of the continuity between the gaseous and liquid states was worked out by many years of laborious and minute measurement of phenomena scarcely sensible to the naked eye.

Here, then, we have a very full recognition of the importance of accurate measurement, by one who has a perfect right to speak authoritatively on such a subject. It may indeed be maintained that no accurate knowledge of any thing or any law in nature is possible, unless we possess a faculty of referring our results to some unit of measure, and that it might truly be said *to know is to measure*.

To resort to a homely illustration of this proposition, let us suppose a traveller in the unknown wilds of the interior of Africa, observing before him a number of elevations of the ground, not differing materially from one another in apparent magnitude. Without measuring apparatus the traveller could form no conclusion regarding the geographical importance of those visible objects, which might be mere hillocks at a moderate distance, or the domes of an elevated mountain range. In stepping his base line, however, and mounting his distance measurer, he soon ascertains his distances and observations with the sextant and compass, give the angles of elevation and position of the objects. He now knows that a mighty mountain chain stands before him, which must determine the direction of the watercourses and important climatic results. In short, through measurement he has achieved perhaps an important addition to our geographical knowledge. As regards modern astronomy, this may almost be defined as the art of measuring very distant objects, and this art has progressed proportionately with the perfection attained in the telescopes and recording instruments employed in its pursuit.

By the ancients the art of measuring length and volume was tolerably well understood, hence their relatively extraordinary advance in architecture and the plastic arts. We hear also of powerful mechanical contrivances which Archimedes employed for lifting and hurling heavy masses, and the books of Euclid constitute a lasting proof of their power of grappling with the laws regulating the proportion of plane and linear measurement. But with all the mental and mechanical power displayed in those works, it would seem strange that no attempt should have been made on the part of the ancients to utilise these subtle forces in nature, *heat* and *electricity*, by which modern civilisation has been distinguished, were it not for their want of the means of *measuring* these forces.

Hero of Alexandria tells us that the power of steam was known to the Egyptians, and was employed by their priesthood to work such pretended miracles, as that of the spontaneous opening of the doors of the temple whenever the burnt offering was accepted by the gods, or as we moderns would put it whenever the heat generated by combustion was sufficient to produce steam in the hollow body of the altar, and thus force water into buckets whose increasing weight, in descending, caused the gates in question to open.

Unfortunately for them, the Accademia del Cimento of Florence had not yet presented the world with the thermometer, nor had Torricelli shown how to measure elastic pressures, or there would at any rate have been a probability of those clear-headed ancients applying the power of steam for preparing and transporting the materials, which they used in the erection of their stupendous monuments, and for raising and directing the water used in their elaborate works of irrigation.

The art of measuring may be divided into the following principal groups:—

First. That of linear measurement, the measurement of area within a plane and of plane angles, comprising Geometry, Trigonometry, Surveying, and the construction of linear measures, distance meters, sextants, and plain meters, of which a great variety will be found within this building.

The subject of linear measurement will I am happy to state be brought before you by one whose name will ever be remembered as the introducer into applied mechanics of the absolute plane and of accurate measure, I mean Sir Joseph Whitworth. It is to be regretted I consider that Sir Joseph Whitworth adopted as the unit of measure, the decimalised inch instead of employing the centimetre, and I hope that he will see reason to adapt his admirable system of gauges also to metrical measure, which, notwithstanding any objections that could be raised against it on theoretical grounds—that, namely, of not representing accurately the ten millionth part of the distance from one of the earth's poles to the equator—is nevertheless the only measure that has been thoroughly decimalised, and which establishes a simple relationship between measures of length, of area and of capacity. It possesses moreover, the great practical advantage of having been adopted by nearly all the civilised nations of Europe and by scientific workers throughout the world. Sir Joseph Whitworth's gauges, based upon the decimalised inch are calculated to maintain their position for many years, owing to the intrinsic mechanical perfection which they represent, but the boon conferred by their author would be still greater than it is if by adopting the metre he would remove the last and only serious impediment in the way of the unification of linear measurement throughout the world. A discussion will probably arise regarding the relative merits of measurement *à bout* of which Sir Joseph Whitworth is the representative, and of measurement *à trait* which is the older method but is still maintained by the Standard Commissioners both in this country and in France.

The second group includes the measure of volume or the cubical content of solids, liquids, and gases, comprising stereometric methods of measurement, the standard measures for liquids, and the apparatus for measuring liquid and gaseous bodies flowing through pipes, such as gas meters, water meters, spirit meters, of which likewise a great variety of ancient and modern date will meet your eye, and upon which Mr. Merrifield will address you.

Another method of measuring matter is by its attraction towards the earth, or thirdly the measurement of weight represented by a great variety of balances of ancient and modern construction. These may be divided into *beam weighing machines* which appear to be at the same time the most ancient and the most accurate, into spring balances and torsion balances. The accuracy obtained in weighing is truly surprising when we see that a mass of one ten millionth part of a gramme suffices to turn the scale of a well constructed chemical balance. Perfect weighing, however, could only be accomplished in a vacuum, and, in accurate weighing, allowance has to be made for the weight of air displaced by the object under consideration. The general result is that the mass of light substances is really greater than their nominal weight implies, and this difference between true and nominal weight must vary sensibly with varying atmospheric density.

Weighing in a denser medium than atmospheric air, namely in water, leads us fourthly to the measurement of specific gravity which was originated by Archimedes when he determined the composition of King Hiero's crown by weighing it in water and in air.

Among measures of weight, may be noted a balance,

which weighs to the five-millionth part of the body weighed, sent by Beckers Sons of Rotterdam; another from Brussels weighing to within a fourteenth millionth part of the weight, in weighing small quantities; a balance formerly used by Dr. Priestley; and Professor Hennessy's standards derived from the earth's polar axis, as common to all terrestrial meridians.

Next comes fifthly, *the Measurement of Time*, which although of ancient conception has been reduced to mathematical precision only in modern times. This has taken place through the discovery by Galileo, of the pendulum, and its application by Huygens to time-pieces in the 17th century. The most interesting exhibits in this branch of measurement are, from an historical point of view, the Italian, German, and English clocks of the 17th century, the Timekeeper which was twice carried out by Captain Cook, first in 1776, and which, after passing through a number of hands, was brought back to this country in 1843, and an ancient striking clock, supposed to have been made in 1348; it has the verge escapement which is said to have been in use before the pendulum. The methods employed in modern clocks and watches for compensating for variation of the thermometer and barometer, are illustrated by numerous exhibits, notably the Astronomical Clock, with Sir George Airy's compensation, which will form the subject of a special demonstration by Messrs. Dent and Co.

The measurement of small increments of time has been rendered possible only in our own days by the introduction of the conical pendulum, and other apparatus of uniform rotation, which alone conveys to our minds the true conception of the continuity of time. Among the exhibits belonging to this class, must be mentioned Sir Charles Wheatstone's rotating mirror, moved by a constant falling weight, by which he made his early determination of the velocity of electricity through metallic conductors; the rotative cylindrical mirror, marked by successive electrical discharges, which was employed by Dr. Werner Siemens in 1846, to measure the velocity of projectiles, and has been lately applied by him for the measurement of the velocity of the electric current itself, and the Chronometric Governor, introduced by him in conjunction with myself, for regulating Chronographs, as also the velocity of steam engines under their varying loads; Foucault's Governor, and a considerable variety involving similar principles of action.

Another entity which presents itself for measurement is, sixthly, that of *Velocity*, or distance traversed in a unit of time, which may either be uniform or one influenced by a continuance of the cause of motion, resulting in acceleration, subject to laws and measurements applicable both in relation to celestial and terrestrial bodies. I may here mention the instruments latterly devised for measuring the acceleration of a cannon-ball before and after leaving the mouth of the gun, of which an early example has been placed within these galleries. Other measurers of velocity are to be found here, Ships' Logs, Current Meters, and Anemometers.

In combining the ideas of weight or pressure with space, we arrive at seventhly, the conception of work, the unit of which is the foot-pound or kilogrammetre, and which, when combined with time, leads us to the further conception of the performance of duty, the horse-power as defined by Watt. The machines for the measurement of work, here exhibited, are not numerous, but are interesting. Among these may be mentioned Professor Colladon's Dynamometrical Apparatus constructed in 1844; Richard's Patent Steam Engine Indicator, an improvement on Watt's, and Mr. G. A. Hirn's Flexion and Torsion Pandynamometers.

Eighth. The Measurement of *Electrical Units*—of electrical capacity of potential—and Resistance, forms a subject of vast research, and of practical importance, such as few men are capable of doing justice to. It may be questioned, indeed, whether Electrical Measurement belongs to the province of mechanical science, involving, as it does, problems in physical science of the highest order; but it may be contended on the other hand that at least one branch of Applied Science, that of Telegraphy, could not be carried on without its aid. I am happy to say that this branch of the general subject will be brought before you by my esteemed friend Sir William Thomson, than whom there is no one more eminently qualified to deal with it. I may, therefore, pass on to the next great branch of our general subject, the ninth: *Thermal Measurement.*—The principal instrument here employed is the thermometer, based in its construction, either upon the difference of expansion between two solids, or on the expansion of fluids such as mercury or alcohol—(the common thermometer) or upon gaseous expansion (the air thermometer); or again, it may be based upon certain changes of electrical resistance, which solids and liquids experience when subjected to various intensities of heat. With reference to these, the air thermometer represents most completely the molecular action of matter which is the equivalent of the expansibility. I shall not speak of the different scales that have been adopted by Réaumur, Celsuis and Fahrenheit, which are based upon no natural laws or zero points in nature, and which are therefore equally objectionable upon theoretical grounds. Would it not be possible to substitute for these a natural thermometric scale? One commencing from the absolute zero, of the possible existence of which we have many irrefutable proofs, although we may never be able to reach it by actual experiment. A scale commencing in numeration from this hypothetical point would possess the advantage of being in unison throughout with the physical effects due to the nominal degree, and would aid us in appreciating correctly the relative dynamical value of any two degrees of heat which could be named. Such a scale would also fall in with the readings of an Electrical Resistance Thermometer or Pyrometer, of which a specimen has been added to this collection by myself.

When temperature or intensity of heat is coupled with mass we obtain the conception of quantity of heat, and if this again is referred to a standard material, usually water, the unit weight of each being taken, we obtain what is known as specific heat. The standard to which measurements of quantity of heat are usually referred is the heat required to raise a pound of water one degree Fahrenheit, or the cubic centimetre of water one degree Centigrade.

The most interesting exhibits in this branch of measurement, are, from an historical point of view, the original spirit thermometer of the Florentine Academia del Cimento, and the photographs of old thermometers; the original Lavoisier Calorimeter for measuring the heat disengaged in combustion, Wedgwood's and Daniell's Pyrometers.

As illustrating modern improvement may be instanced a long brass-cased thermometer showing the variation in the readings, when the bulb and when the whole thermometer is immersed; a thermometer with flat bulb to improve sensitiveness; a thermo-electric alarum, for giving notice when a given temperature is reached; an instrument for measuring the temperature of fusion by means of electric contact invented by Prof. Himly; Dr. Andrews' apparatus for measuring the quantity of heat disengaged in combustion; Dr. Guthrie's diacalorimeter for measuring the conductivity of liquids for heat, and a thermometrictu be by Prof. Wartmann for determining the calorific capacities of different liquids by the process of cooling.

Finally, Joule has taught us how to measure the unit of heat dynamically, and the interesting apparatus employed by him from time to time in the various stages of the determination of this most important constant in applied mechanics, are to be found, rightly placed, not among thermometers, and other instruments placed in the physical sections, but among the instruments required in

the determination of three great natural standards—of length, time, and mass, and their combinations.

Another branch of the general subject is the *Measurement of Light*, which may be divided into two principal sections, that including the measurement of the wave-length of lights of different colours, and the angle of polarization, which belongs purely and entirely to physical science; and the measurement of the intensity of light by photometry, which, while involving also physical problems of the highest order, has an important bearing also upon applied science. The principal methods that have been hitherto employed in photometry are by the comparison of shadows, that of Rumford and Bouguer; by employing a screen of paper with a grease-spot, the lights to be compared being so adjusted that the spot does not differ in appearance from the rest of the paper, Bunsen's method; Elster's, by determining in combustion the amount of carbon contained in a given volume of a gas; and the one lately introduced by Prof. Adams and Dr. Werner Siemens, by measuring the variation in the electrical resistance of selenium, under varying intensities of light.

Before concluding, I wish to call your attention to two measuring instruments which do not fall within the range of any of the divisions before indicated. The first is an apparatus designed chiefly by my brother, Dr. Werner Siemens, by which a stream composed of alcohol and water, mixed in any proportion, is measured in such a manner that one train of counter wheels records the volume of the mixed liquid; whilst a second counter gives a true record of the amount of absolute alcohol contained in it. The principle upon which this measuring apparatus acts may be shortly described thus:—The volume of liquid is passed through a revolving drum, divided into three compartments by radial divisions, and not dissimilar in appearance to an ordinary wet gas-meter; the revolutions of this drum produce the record of the total volume of passing liquid. The liquid on its way to the measuring drum passes through a receiver containing a float of thin metal filled with proof spirit, which float is partially supported by means of a carefully-adjusted spring, and its position determines that of a lever, the angular position of which causes the alcohol counter to rotate more or less for every revolution of the measuring drum. Thus, if water only passes through the apparatus the lever in question stands at its lowest position, when the rotative motion of the drum will not be communicated to the alcohol counter, but in proportion as the lever ascends a greater proportion of the motion of the drum will be communicated to the alcohol counter, and this motion is rendered strictly proportionate to the alcohol contained in the liquid, allowance being made in the instrument for the change of volume due to chemical affinity between the two liquids. Several thousand instruments of this description are employed by the Russian Government in controlling the production of spirits in that empire, whereby a large staff of officials is saved, and a perfectly just and technically unobjectionable method is established for levying the excise dues.

Another instrument, not belonging to any of the classes enumerated, is one for measuring the depth of the sea without a sounding line, which has recently been designed by me, and described in a paper communicated to the Royal Society. Advantage is taken in the construction of this instrument, of certain variations in the total attraction of the earth, which must be attributable to a depth of water intervening between the instrument and the solid constituents of the earth. It can be proved mathematically that the total gravitation of the earth diminishes proportionately with the depth of water, and that if an instrument could be devised to indicate such minute changes in the total attraction upon a scale, the equal divisions on that scale would represent equal units of depth. (See NATURE, vol. xiii., p. 431.)

Gravitation is represented in this instrument by a column of mercury resting upon a corrugated diaphragm of thin steel plate, which in its turn is supported by the elastic force of carefully tempered springs representing a force independent of gravitation. Any change in the force of gravitation must affect the position of this diaphragm and the upper level of the mercury, which causes an air-bubble to travel in a convolute horizontal tube of glass placed upon a graduated scale, the divisions of which are made to signify fathoms of depth. Special arrangements were necessary in order to make this instrument *parathermal*, or independent of change of temperature, as also independent of atmospheric density, which need not be here described. Suffice it to say that the instrument, which has been placed on board the S. S. *Faraday* during several of her trips across the Atlantic, has given evidence of a remarkable accordance in its indications with measurements taken by means of Sir William Thomson's excellent pianoforte wire-sounding machine; and we confidently expect that it will prove a useful instrument for warning mariners of the approach of danger, and for determining their position on seas, the soundings of which are known.

Another variety of this instrument is the horizontal attraction meter, by which it will be possible to obtain continuous records of the diurnal changes in the attraction of the sun and moon as influencing the tides. This instrument belongs, however, rather to the domain of physics than to that of mechanical science.

These general remarks upon the subject of measurement may suffice to call your attention to its importance, several branches of which, those of *Linear*, *Cubical*, and *Electrical Measurement*, will now be dealt with.

The discussions which will follow these addresses will be carried on under circumstances such as have never before co-operated, namely, the presence of leading men of science of all civilised nations, who will take part in them, and the easy reference which can be had to the most comprehensive collection of models of scientific apparatus—both of modern and ancient—which has ever been brought together.

SCIENCE AT THE MANSION HOUSE

FOR the first time probably in the history of this country, science has been publicly acknowledged as a great force or power in the kingdom, on a level with literature and art. This, we think, is the legitimate conclusion to be drawn from the entertainment on Saturday by the Lord Mayor at the Mansion House of so many distinguished representatives of science, following hard as it did upon the opening of the loan collection by her Majesty the Queen. The company was numerous—there were about 300 present—as well as distinguished, and included several eminent foreign representatives of science, who have come over to the opening of the loan collection. The meeting was quite as successful as such meetings usually are, and the speeches on the whole much more sensible and appropriate. The following report of the speeches we take from the *Morning Post*:—

The Lord Mayor, in proposing the toast of the evening, "The Representatives of Science," spoke very happily. We were scarcely, he said, conscious of what we owed to science. If the inventor of the first small crane or lever for lifting water from a well were to come upon the scene now-a-days he would have some difficulty in persuading himself that it was the same world, and not some kind of paradise very far in advance of the world with which, in his day, that person was acquainted. Science was one of the mightiest of all the intellectual pursuits that man could follow. His Lordship said he had an intense admiration for the representatives of literature, but he could hardly express the feelings with which he regarded the men who laboured in the various phases of science. What did we owe to it? and what

were we coming to? To science we owed every easement we enjoyed in the work of our daily life. Science enabled us, in comparison with past generations, to live our lives over and over again. It enabled us to travel such mighty distances within so short a space of time as a few years ago would have been inconceivable; and, what with the aid of the electric telegraph, it placed us in almost immediate communication with nearly all parts of the world. Having referred to the vast saving of manual labour which had been effected through the aid of science by machinery and appliances of various kinds, his Lordship expressed his gratification at the presence of representatives of so many branches of science.

Dr. Hooker, who was the first to respond, remarked that the occasion might be regarded as marking an important epoch in the history of science. It had been his pleasure to attend the various exhibitions for the promotion of science and art which had been held in this country and abroad by our own and by other Governments since 1851, and not only to study their contents but also to inquire into their origin and connection, and what might be called their individuality. With respect to the exhibition which the present banquet might be said to commemorate, he could see many marks which distinguished it from those that had gone before it. It had been brought to its present remarkable state by the indomitable energy of a very few workers whom it might be invidious to particularise, though he could not forbear mentioning the name of Mr. Lockyer. Originating as it did almost spontaneously, it had received the support of the Government from the active interest that was taken in it by the Lord President and the Vice-President of the Council, and from the diplomatic action which resulted in getting foreign Governments to send their delegates to visit the exhibition and to take part in conferences on the occasion of its opening. It had derived no small support from the countenance which had been graciously bestowed upon it by the Queen. In continuation, Dr. Hooker said, look at the state of science now and what it was 300 years ago. It had advanced with such strides as had marked the progress of no other branch of intellectual pursuit. Compare, or rather contrast, the progress of science in modern times with that of literature and the fine arts. With regard to literature, as with regard to the fine arts in this country, more especially in the case of sculpture and architecture, we had to look back ages almost to find a starting-point in their general progress, and even in the case of the most modern of the fine arts—painting—we were referred back to the cradles of its birth in Italy, Spain, and the Low Countries. With regard to the Exhibition for the Advancement of Science, what was to be its future? Was it to be a matter of a few weeks or months, and then to pass away for ever? It was to be hoped not. It was the earnest desire of scientific men to form the nucleus of a great national museum of a permanent character for the benefit not only of scientific men but for the benefit of the public in general, and he felt sure that science would not look to the public in vain for aid in the endeavour to realise that important object. It was an object worthy of great and noble efforts, and he felt assured that such efforts would not be wanting on the part of the City of London.

After a few remarks from Sir John Hawkshaw, Sir George Airy, the Astronomer Royal, replied for that branch of the toast which he represented, and spoke of science under two heads, which, for want of better terms, he said he might describe as practical and contemplative science. Of the present state of practical science it was impossible to speak too highly. It was impossible for any one who had even a partial acquaintance with what was going on in our manufacturing districts especially, and in all those labours which were for the benefit of mankind, not to be struck with the enormous amount of ingenuity and enterprise which were brought to bear upon those industries with a view to material gain. Material gain was the aim of practical science. As for what he termed the contemplative branch of science, which embraced especially all those pursuits relating to the constitution of nature, the object in that case was not material gain or personal advantage, but the results at which it aimed were in their way not inferior to or less welcome than those of practical science.

Mr. Justice Grove in proposing "The Health of the Lord Mayor," humorously remarked that his lordship when inviting such a body of representatives of science to partake of his splendid hospitality, must have been actuated, not only by a lively sense of favours received, but also by a lively sense of favours to come. Mindful of what science had done for commerce and manufactures in the past, the first magistrate of the city of London had doubtless an eye at the same time to the advantages which manufactures and commerce would reap from the labours of science in the future. There was nothing in which the Lord Mayor could do himself more honour than in entertaining at his table the votaries of science, to whom, on the other hand, nothing could be more gratifying or encouraging than this mark of recognition and appreciation on his part of the value of their labours.

To the toast of "The Foreign Representatives of Science," Prof. Blaserna responded.

Altogether, we think, both the Lord Mayor and the representatives of science are to be congratulated on the success of this entertainment, which will no doubt form a precedent for future ones of a similar kind.

NOTES

COL. PREJEVALSKY is about to set out on a new exploring journey into Central Asia, which will probably last for about three years. His purpose is to explore especially the basin of the Lob-nor from Thian-shan to the Himalayas. Col. Prejevalsky proposes to visit this summer Eastern Thian-shan from Kulogra to Hama, and to pass the winter upon the Lob-nor and in the deserts which extend to the east of this lake, mainly to solve the question as to wild horses and camels. Next spring he will observe the migrations of birds on Lob-nor and proceed to Lhassa. He will then explore the upper course of the Brahamapootra and the northern slopes of the Himalayas, as also Eastern Thibet and Southern China, and if circumstances permit, he will return by Western Thibet and enter Russia by Kashgar. The programme of the expedition is as follows: 1. Geographical and ethnographical descriptions. 2. An itinerary sketch at sight. 3. Astronomical determinations of places. 4. Meteorological, psychometric, and hypsometric observations. 5. Observations of mammals and birds. 6. Botanical, zoological, and mineralogical collections. 7. Photographic sketches. The Russian Geographical Society has expressed its emphatic approval of the programme, and the Emperor has ordered 24,740 roubles to be devoted to the expedition from the treasury.

FROM Commander Cookson we hear that H.M.S. *Petrel* is bringing home two living specimens of the Giant Tortoise of the Galapagos Islands, from Albemarle Island. A large supply of food was provided, and if this does not fail, and at the same time if the cold in the region of Cape Horn has not proved too intense, we may hope to see the specimens alive, for the first time in this country, during next month.

FROM the *Rochester Democrat and Chronicle* (U.S.) we learn that a gentleman of Rochester, New York, who does not wish his name to be published, has, through Prof. Henry A. Ward of that city, given to the University of Virginia, a sum of 5,500*l.* to be expended in the formation of a fully appointed cabinet of the

natural sciences, including mineralogy, geology, and zoology The donor has also given a building, at the cost of more than 4,000*l*., for the collection to be built near Charlesville, four miles from Monticello Prof Ward, in making the collection, will visit the principal European cities

In the *Proceedings of the Royal Irish Academy*, p 427, Dr Robinson gives us a paper on the theory of the cup anemometer, and the determination of its constants The paper is an extremely valuable one, as indicating the line of research to be followed in prosecuting anemometrical experiments So far as we are aware, Dr Robinson is the first who has formed a just apprehension of the viscosity of the air in its bearings on such experiments, and adopted the necessary precautions in accordance therewith

At the meeting of the Edinburgh Botanical Society, held on the 11th inst, an interesting communication was read from the Rev D Landsborough, on experiments in growing several Australian plants and trees in Arran, in the Firth of Clyde, including among others the great Australian tree fern and other tree ferns, acacias, and gum trees The blue gum grew 11½ inches the first year 4 feet the second, and 6 feet the third The *Eucalyptus pendulosa* also grows well in sheltered situations along the west coast, and Mr Landsborough expects to see it generally introduced in a few years, and form a valuable addition to our evergreen shrubs

A correspondent writes with reference to the "Plaster cast of portion of antler of reindeer from La Madelaine, Dordogne France in the loan collection, the original of which is preserved in France The thicker end, the label states, is pierced with a hole "There are as many as four holes in some specimens Their use is unknown" Our correspondent states that these implements may have been used by former inhabitants of France in the same manner as a very similar tool usually made of deer horn is now in use or was very recently, by some tribes of the "Red men" of North America Where bows and arrows are in use, the arrows are made of a very hard and tough willow This willow may not always be quite straight, or is liable to get warped or crooked in the process of drying If so the bent or curved parts are straightened by the intended arrow being put through the hole in the horn, and a strong pressure applied in the proper direction to counteract the curve This has sometimes to be done over and over again before perfect straightness is obtained It may be asked why are three or four holes sometimes found in the same piece of horn? If the holes are of different sizes the reply is not difficult It is probable that the people who use these tools had wood of different thicknesses (say for arrows and spears) to manipulate, if so, holes of different sizes would be required It will, he thinks, be generally noticed that the edges of the holes are rounded, this would be done to prevent the otherwise sharp edge injuring the fibre of the wood. Near the specimen referred to, there is one in which one side of the hole has apparently been broken away by a violent strain, possibly applied in the manner and for the purpose above stated

The able director of the Royal Zoological Museum of Lisbon, José Vincente Barboza du Bocage, well known for his valuable researches on the natural history of the shores of Portugal, and especially on the Fauna of the Portuguese possessions in Africa, was unanimously elected a foreign member of the Linnean Society at their last meeting, May 4 Prof William Nylander, of Helsingfors, a cryptogamic botanist of deservedly high reputation, also had the same honorary distinction conferred on him

Parts xlvii and xlviii. of Mr. Dresser's "History of the Birds of Europe," completing the fourth annual volume of this important work, has just been issued with its usual punctuality Nearly 400 species of birds have now been figured and described, and as the total European avifauna is probably between 600 and 700 species, three more volumes will be required These will, almost certainly, be issued within three years from the present date, and we may therefore with great confidence anticipate the successful conclusion of a monograph, which, whether for the beauty of its illustrations, or for the fulness and accuracy of its information, will stand in the very first rank of ornithological literature

In Petermann's *Mittheilungen* for May is an article, accompanied by a map, showing the number, classification, distribution &c, of the institutions for higher instruction in Germany Following the continuation of the analysis of Prejevalsky's Mongolian travels is an interesting article on the recent travels of Dr Emil Holub in South Africa, mainly in the Limpopo and Zambesi regions and the region of the salt pans between Chutimi and Mamusa The information seems to be mainly obtained from the *Diamond News and Griqualand West Government Gazette* of Feb 23, 1875 Probably the most interesting article is a detailed account of Giles's expedition from Beltana in South Australia, to Perth in Western Australia, in May November, 1875 Giles's route was on an average four degrees to the south of Forrest's, which, again, was about the same distance south of that of Warburton Giles has the same barren tale to tell as his predecessor We believe he is to make a diagonal journey from north west to south east, though from this we can hardly expect many new results A valuable map accompanies the paper in the *Mittheilungen*, which is to be continued

The latest news received by the Russian Geographical Society from Dr Miclucho Maclay is dated from Cheribon (Java) in March last He announces that before leaving Batavia he sent to St Petersburg many zoological collections, and will bring his anthropological and ethnographical collections to Europe on his return, in 1877

A branch of the Russian Geographical Society will probably be shortly founded at Omsk, in Siberia

M de Mainof, Secretary of the Ethnographical Section of the Russian Geographical Society, has announced to the society that he is preparing a complete treatise on Russian ethnography It will appear in parts, each containing a description of a section of the people

M L Estourgies has been charged by the Belgian Government, in company with M Sylvain Jacquemin, civil engineer, to make a scientific journey through the Transvaal Republic

There is to be a Congress of Alpine Clubs at Pistoja and Florence on June 10 and 11 Several expeditions have been arranged

Mr J H Angus has made a gift to the Adelaide University, of a scholarship of 2,000*l* yearly, tenable for three years, to encourage the training of scientific men, especially civil engineers, with a view to their settlement in South Australia, the winner of the scholarships to spend six months of the term in visiting the great engineering works of Europe or America, towards which the donor gives 100*l* additional

Mails for the Polar ships *Alert* and *Discovery* will be made up for conveyance from Portsmouth on or about May 25, by the steam yacht *Pandora*, Capt Allen Young having kindly consented to convey letters for the officers and crews of the Polar ships to be deposited at the depots All letters should be sent through the post-office prepaid the inland rate of postage, and addressed "Arctic Yacht *Pandora*, Portsmouth." No letters

containing articles of value should be sent. No newspapers should be sent, as the Admiralty will send a sufficient supply.

THE University of Oxford is to confer upon Dr. Warren De la Rue the degree of M.A. by diploma.

THE ANNUAL Meeting of the Victoria Institute is postponed from the 22nd to the 29th of May.

LIEUT. CAMERON will, on Tuesday next, read to the Anthropological Society a paper on the Anthropology of Central Africa, in the theatre of the Royal School of Mines, Jermyn Street, at 8.30 P.M.

DOCENT THEEL, zoologist, a member of the Swedish Expedition of last year, to Novaya Zemlya, Docent Arnell, botanist, and Dr. Trybom, entomologist, have left Stockholm for Riga, whence they proceed overland to Siberia, where they will remain till autumn, making scientific observations and collections, and returning by the steamer *Ymer*, which Prof. Nordenskjöld has chartered for a voyage to the Yenisei.

M. JANSSEN, although he has not yet obtained possession of his regular observatory, has established large photographising telescopes at his residence at Montmartre. He found that during the cold period from the beginning of May up to the 10th, the sun had no spots at all. The photographs are about twenty centimetres in diameter.

C. M. STUART, of Harrow School, has been elected to the Natural Science Exhibition at St. John's College, Cambridge. A second exhibition was at the same time conferred on J. Nall, of Manchester Grammar School.

AT a recent meeting of the French Academy, M. Lecoq de Boisbaudran communicated some further facts regarding the new metal gallium. The specimen he had formerly presented owed its solidity to the presence of a small quantity of foreign bodies. Pure gallium, of which he had now prepared nearly ten centigrammes, melts at about 29°·5 C.; hence it liquefies when it is seized between the fingers. It is very easily held in superfusion, which explains how a globule has been kept liquid for weeks in temperatures descending occasionally almost to zero. Electrolysed gallium from ammoniacal solution is identical with that obtained from potassic solution. Once solidified, the metal is hard and resistant, even at a few degrees under its melting point; but it can be cut, and has a certain malleability. Melted gallium adheres easily to glass, on which it forms a beautiful mirror, whiter than that produced by mercury. Heated to a bright red in presence of air, gallium oxidises but very superficially, and does not volatilise; it is not sensibly attacked in the cold state by nitric acid, but in heat the solution operates with liberation of nitrous vapours. The density of the metal (determined approximately from a specimen weighing sixty-four milligrammes) is 4·7 at 15°, and relatively to water at 15°. The mean of the densities of aluminium and of indium is 4·8 at zero. Thus the density confirms theoretical prevision, while the extreme fusibility is a fact completely unexpected.

THE Marine tanks of the Royal Aquarium, Westminster, are being rapidly filled with water brought from Brighton by Messrs. Hudson, who supplied the Crystal Palace. For some time past many of the fresh-water tanks have been stocked, but the first marine fish has but quite recently arrived. It is a somewhat rare one in captivity—the *Motella tricerata* (Yarrell), commonly called the spotted leopard fish. It is placed in a central tank, so that the peculiarity of the "fin" in the neck can be well seen. Couch, in his "History of Fishes," refers to this fin as being always in rapid action, but with this particular specimen it is often at rest. He points out that while its intimate structure shows that it is destitute of any power of propulsion or of regulating motion, it is well furnished with nerves which render it acutely sensible to impression. The functions of the fin have, so far as we know, not been determined.

MR. WALPOLE, on Tuesday, moved for leave to introduce "A Bill for making further provision respecting the University of Cambridge and the Colleges therein." Following the recommendations of the Duke of Devonshire and the Oxford and Cambridge University Commissions, he indicated the nature of the changes desired as follows:—The extension of the professoriat, and a complete organisation of the system of inter-collegiate lectures and classes, for which provision would have to be made over and above that which had already been made, for museums, libraries, and the other apparatus which might be necessary for the prosecution of scientific investigation. The following are the names of the seven Commissioners it is proposed to appoint:—The Bishop of Worcester, Lord Rayleigh, the Lord Chief Justice, the Right Hon. E. P. Bouverie, Prof. Stokes, Rev. Prof. Lightfoot, and Mr. G. W. Hemmings. Mr. Cross said the Bill might be regarded for all practical purposes as a Government measure.

THE animals deposited in the Gardens of the Zoological Society by H.R.H. the Prince of Wales, include, among others, two Musk Deer (*Moschus moschiferus*); two Thar Goats (*Capra jemlaica*); four Indian Elephants (*Elephas indicus*), aged about 7, 6, 1½ and 1½ years; five Tigers, (*Felis tigris*); a Cheetah (*F. jubata*); a Viverrine Cat (*F. viverrina*); five Leopards (*F. pardus*); an Indian Civet Cat (*Viverricula indica*); two Dwarf Zebus (*Bos indicus*); seven Indian Antelopes (*Antilope cervicapra*); three Axis Deer (*Cervus axis*); three Ostriches (*Struthio camelus*); several pairs of Impeyan Pheasants (*Lophophorus impeyanus*); Cheer Pheasants (*Phasianus wallichii*); Horned Tragopans (*Ceriornis satyra*); Chukar Partridges (*Caccabis chukar*). Besides the Prince's specimens, the following are the most important additions of the week:—Two Secretary Vultures (*Serpentarius reptilivorus*), presented by Mr. M. G. Angel; an Egyptian Cobra (*Naja haje*), presented by the Rev. G. H. R. Fisk; and a Maholi Galago (*Galago maholi*), presented by Dr. R. A. Zeederberg, all from S. Africa.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 4.—On the Modification of the Excitability of Motor Nerves produced by Injury, by G. J. Romanes, M.A., F.L.S.

It has long been known that when a nerve is cut, or otherwise injured, its excitability at or near the seat of injury undergoes a marked increase. No one, however, has attempted to determine the relative degree of this increase towards make and towards break of the current respectively. The author found that when the nerve-section rested on the *kathode*, the *increase* of excitability was manifested towards *make*, and scarcely at all towards break; while, conversely, when the section rested on the *anode*, such *increase* was manifested towards *break*, and scarcely at all towards make. These facts are of considerable interest in relation to the theory of electrotonus. The *degree* of the latter increase, however, is out of all proportion greater than that of the former; for while the ratio of excitability before and after cutting was represented by the numbers 36 : 46 in the case of the kathodic make, such ratio was represented by 2 : 32 in the case of the anodic break. Mr. Romanes explains this disproportion by the consideration, that as the sensitiveness to the kathodic make is so much greater than is that to the anodic break *before nerve-section*, after the general sensitiveness of the nerve has been increased by section, the increase has not so much room to assert itself in the former as it has in the latter case, before it reaches zero of the stimulating current's intensity. Thus the figures 2 : 32 :: 36 : 46, though not expressing any *numerical* proportion, may yet express a *real* proportion, if the zero of the current's intensity be represented say by 50 in the above scale of nervous excitability, and if it be granted that the value as a stimulus of any given increment of current is determined by the proportion which such increment bears to the intensity of current that is required to produce adequate stimulation. This explanation is confirmed by a method of graduating the galvanic stimulus other than that of graduating the intensity of the current, viz., by

graduating its *duration*. In this way it was found that, in respect of voltaic stimuli of very short duration, the sensitiveness to the kathodic make is much more increased by cutting than is that to the anodic break.

Mr. Romanes further observed that when a frog's gastrocnemius is subjected to a weak galvanic current, a part or parts of it will sometimes pulsate in a strictly rhythmical manner. This was proved to be a nervous effect by observing that it ceased when the attached sciatic was thrown into anelectrotonus.

With minimal stimulation of curarised muscle, the author found that considerably more effect is produced by first laying on the anode and then the kathode, than is produced if this order is inverted. This fact is just the converse of what Hitzig found to be true of cerebral stimulation, and as such it may be taken as confirmatory of his views concerning the reversed relations that subsist between central and peripheral voltaic excitation.

May 11.—"On some Thallophytes parasitic within recent Madreporaria." By P. M. Duncan, M.B. F.R.S., President of the Geological Society.

"Condensation of Vapour of Mercury on Selenium in the Sprengel Vacuum." By R. J. Moss, F.C.S., Chemical Laboratory, Royal Dublin Society. Communicated by G. Johnstone Stoney, F.R.S.

Royal Microscopical Society, May 3.—Mr. H. C. Sorby, F.R.S., president, in the chair.—Mr. Chas. Brooke, F.R.S., proposed a special vote of thanks to the president for the conversazione given by him on the 21st inst.—A paper was read by Mr. Blake on the occurrence of what appeared to be Foraminifera in the coralline oolite, and specimens in illustration were exhibited under microscopes in the room.—Mr. J. Glaisher communicated a paper by Dr. Gayer, describing the apparatus employed and the process adopted by him in India for the purpose of taking photo-micrographs with high powers.—A paper by Dr. J. J. Woodward on the markings of the body-scale of the English gnat and the American mosquito was read by the Secretary.—Some notes upon the same subject by Dr Anthony were also communicated.—A short paper by Mr. Stodder on the identity of *Frustulia saxonica*, *Navicula rhomboides*, and *N. crassinervis* was read by the Secretary.—Mr. Chas. Stewart called attention to a curious living organism exhibited by Mr. Badcock, and which the Fellows present were requested to examine with a view to its identification.

Victoria (Philosophical) Institute, May 8.—After the election of new members, of whom fifty were announced as having been admitted during the past four months, it was stated that Prof. Birks would deliver the Annual Address for 1876.—A paper on the metaphysics of Scripture was then read by Prof. Challis, F.R.S.

BERLIN

German Chemical Society, March 27.—A. W. Hofmann, president, in the chair.—A. Fluckiger has proved the presence of *carvacrol* in the oils of *mentha viridis* and of *anethum graveolens* by producing its characteristic combination with sulphuretted hydrogen.—O. Fischer described nitroso-acetanilide, $NC_6H_5 . C_2H_3O . NO$, an unstable compound from which acetaniline is easily reproduced.—J. Dummer, by the action of amidophenol, $C_6H_4OHNH_2$, on sulphuret of carbon, has obtained an oxysulphocyanide of phenyl, C_7H_5NSO.—W. Smith has observed, that by passing through a red-hot tube naphthaline-vapour together with terchloride of antimony or tetrachloride of tin, a good yield of dinaphthyle is formed—

$$6C_{10}H_8 + 2SbCl_3 = Sb_2 + 6HCl + 3C_{20}H_{14}.$$

W. Thoerner has studied the action of hydrogen and of chlorine on tolylphenyl ketone. The latter gives rise to three crystallised substitution compounds:—

$$C_6H_5 . CO . C_6H_4 . CH_2Cl, \quad C_6H_5 . CO . C_6H_4 . CHCl_2,$$
and
$$C_6H_5 . CO . C_6H_4CCl_3.$$

The latter with water yields the acid $C_6H_5 . CO . C_6H_4COOH$. With zinc and hydrochloric acid the ketone yields a pinacoline, $\begin{matrix} C_6H_5 \\ C_6H_5 \end{matrix}\!\!>C<\!\!\begin{matrix} C_6H_4CH_3 \\ CO . C_6H_4 . CH_3 \end{matrix}$, as well as an isomeride.—H. Limpricht described a number of substitution-compounds of meta-amido-benzosulphuric acid with bromine.—C. Councler has obtained borate of allyl, $Bo(OC_3H_5)_3$, a liquid boiling at 170°, by the action of boric anhydride on allylic alcohol.—Lothar Meyer, after decomposing sulphate of copper by metallic zinc, found in solution nothing but neutral sulphate of zinc, while metallic copper and basic sulphate of zinc were deposited on the metal. Evolution of hydrogen gas takes place during this process.

April 10.—H. Limpricht described new derivatives of sulphobenzolic acid.—H. W. Vogel reported on the spectroscopic reactions of blood.—Robert Schiff described the action of isosulphocyanide of phenyl with aldehyde-ammonia. The body expected $C = S—NHC_6H_5—NH . \underset{\displaystyle CH_3}{\overset{|}{CH}} . OH$, or $C_{11}H_{19}N_3O_2S$ loses water and ammonia, and yields a well crystallised substance, $C_{22}H_{31}N_5O_2S_2$, thus:—

$$2C_{11}H_{19}N_3O_2S—2H_2O—NH_3 = C_{22}H_{31}N_5O_2S_2.$$

The new body with acetic anhydride yields a phenylated and acetylated sulpho-urea: $C = S—NH . C_6H_5—NH . C_2H_3O$.—G. Schultz has treated isodinitrodiphenyl with tin and hydrochloric acid, thus transforming it into an isomeride of benzidine, called by the author diphenyline, $C_{12}H_8(NH_2)_2$, crystallising in colourless scales, and fusing at 53°.—W. Staedel and L. Rugheimer have studied the action of alcoholic ammonia on chloro-acetyl-benzol $C_6H_5—CO—CH_2Cl$. The results are two bodies. One insoluble in ether, but soluble in boiling alcohol, from which it crystallises in silky needles, fusing at 194°, proved to be isomeric with indol, having the formula $C_6H_5—C—CH_2$.
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$$N$$
—The other substance soluble in ether appears to correspond to the formula $C_6H_5—CO—CH_2NH_2$.—E. Demole, studying the action of bromine on clorhydrine of glycol, has found the following products of reaction: bromide of ethylene, bromochloride of ethylene, bromhydrine of glycol and bromo-acetic ether.—F. Beilstein and A. Kurbatoff have prepared two tetrachlorobenzols in which the four atoms of chlorine are situated at 1 . 2 . 3 . 5 and 2 . 3 . 5 . 6 respectively; by starting from corresponding trichloranilines. The latter when oxydised yields chloranil, from which the authors conclude that in chinone the two atoms of oxygen occupy the positions 1 : 4.—E. Ullrich and H. von Perger described the differences between iso-anthraflavinic and anthroxanthinic acids.—F. Kessler described spectral apparatus for lecture purposes, the novelty of which consists in retransmitting the spectrum through the prism that engendered it, so as to obtain a dispersion of double magnitude.—II. Tollens described a shortened method of obtaining levulinic acid, $C_5H_8O_3$, from fruit sugar.—V. Meyer and F. Forster have repeated M. Emmemann's experience of decomposing normal propylamine with nitrous acid, and they arrive at the result that not only isopropylic alcohol but also normal propylic alcohol and propylene are thus engendered. The latter, combining with water, yields the isopropylic alcohol, the formation of which was hitherto unexplained.—O. Wallach and Th. Heymer have succeeded in combining directly chloral and trichlorolactic acid, thus forming chloralid, and proving that chloralid is the ether of trichlorethylidene with trichlorolactic acid. Lactic acid also combines with chloral.—A. Michaelis and E. Benzinger have reduced nitrophosphenylic acid to *amidophosphenylic* acid,

$$C_6H_4(NH_2) . PO(OH)_2,$$

white brilliant needles soluble in water. With soda-lime they yield aniline and phosphates. Nitrous acid transforms it into nitrate of diazophosphenylic acid: $PO_3H_2 . C_6H_4N = N . NO_3$. Phosphenylic acid and soda-lime yields benzol, while nitrophosphenylic acid and soda lime yields nitro-benzol. The same chemists have produced phosphenyl-bromide, $C_6H_5PBr_2$, a colourless liquid, by passing hydrobromic acid gas into the corresponding chloride. With bromine it forms two solids of the formula $C_6H_5PBr_4$ and $C_6H_5PB_{16}$ respectively.—H. Lecco has obtained from sodium-nitromethane, CH_2NaNO_2, an anhydride, $C_2H_3N_2O_3$.—W. Michler, from an acid lately described dimethylamidobenzoic acid, $C_6H_4 . N(CH_3)_2 . COOH$, has obtained a basic ketone,

$$C_6H_4 . N(CH_3)_2—CO—C_6H_4 . N(CH_3)_2.$$

A third rest, $C_6H_4N(CH_3)_2$ — can replace an atom of hydrogen in this ketone, thus producing a complicated non-basic ketone.—H. Zincke has obtained, by the action of H on β benzoyl-benzoic acid, an anhydride, $\begin{matrix} O — CO \\ | \quad\quad | \\ C_6H_5CH—C_6H_4 \end{matrix}$; and from it, by chloride of phosphorus, anthrachinone.—C. Liebermann and H. Palm described β bromonaphthaline, $C_{10}H_7Br$, obtained from β naph-

thylamine by passing through the corresponding diazo compound and naphthol – A Frank showed zeolith-like crystallisations in slowly-cooled glass The same chemist showed wrought iron transformed into silicium-iron by immersion in molten glass – C Bucking has transformed anisic aldehyde, $C_6H_4\begin{smallmatrix}OCH_3\\COH\end{smallmatrix}$ into paraoxybenzoic aldehyde, $C_6H_5\begin{smallmatrix}OH\\COH\end{smallmatrix}$, fusing at 111°

April 24 – N Gerber described an apparatus for closing the fat contained in milk —P J Anster has transformed solid dibromobenzoles into three isomeric dinitro dibromobenzoles, one of which he transformed into nitro dibromo aniline – R Lbert and V Marz described two isomeric disulphonaphthalic acids, $C_{10}H_6(SO_3H)_2$, formed simultaneously and separated by the unequal solubility of their chlorides in benzol With cyanide of potassium two bicyanides and the corresponding dinaphthoic acids were obtained, while fusion with potash transforms one of the sulpho-compounds into $C_{10}H_6(SO_3H)OH$, which with water yields β naphthol, while the other sulpho compound yields dioxy naphthaline with a melting point 186° – I Woreden discussed the constitution formula of naphthaline —I Priwoznik finds the crystals formed in Leclanche's battery to correspond to the formula $ZnCl_2(NH_3)_2$ – H Vogel defended the spectroscopic analysis of blood, sustaining that the spectroscopic reaction of indigo cannot be confounded with that of blood – A Oppenheim and H I mmerling have continued their researches on the oxidation of oxyuvitic acid Nitric acid yields hydro oxybenzoic acid, while a mixture of sulphuric with fuming nitric acid produces trinitrocresol apparently identical with that obtained by Liebermann from nitro coccinic acid —P Gri s has formed combinations of phenol with one molecule and with two molecules of diazobenzol

VIENNA

Geological Society, Jan 18 —The director, M v Hauer, ... paper by M F Seeland, intended for the Jahrbuch on ... near Huttenberg, in Carinthia in which the author ... led description of the geological relations of these ... y important to the iron industry in the Alpine dis ... n on the scale of 1 : 1440, and some sections, show ... d distribution of the rocks, of which the follow- ... Gneiss, mica s t, tourmaline rock, crys ... mica schist cont ng garnets, amphibolite, ... ica chist, eclogite, besides the beds containing ... Doll showed some min rals from Wildenstein, among them a Pyrrhotite metamorphosed into ... ron ore, which had not been notic d before, pure ... Dr Neumayr, on the geological structure of ... Oenalkidike, on the coast of Macedonia By far ... ea of the whole country i covered with crystall ne ... most varied lith logical c mpo it on In these ... bedded in some parts consi lerable masse of crys- ... rble, for instance on Mount Athos The whole ... of schists and marbles forms a geolog cal unity Of a ... ient date there is only a mall grained gneiss, compos- ... he peninsula of Zongo —Dr R Hoernes, a paper contribut- ... ng to the knowledge of the Megolodontes from the Alps

PARIS

Academy of Sciences, May 8 – Vice Admiral Paris in the chair —The President announced the presence of the International Committee of Weights and Measures, meeting in Paris for the first time since the various States represented had given legal sanction to the convention prepared by the diplomatic conference The following paper were read —On osmium, by MM Sainte Claire Deville and Debray —Note on fermentation, *a propos* of criticisms by Drs Biefeld and Traube, by M Pasteur In a recent brochure Dr Biefeld retracts his assertion that life cannot exist in an atmosphere deprived of oxygen Examples, *Mucor racemosus* and beer yeast —Note on electric transmissions without conducting wires *a propos* of recent papers by MM Bouchotte and Bourbouze, by M Th Du Moncel He recounts experiments he made some thirty years ago, and the theoretical deductions drawn —On a calcareous alabaster from Mexico, by M Damour This new import, known as *onyx de Tecali*, is made into various ornaments, stands, pendulum supports, &c. It has undulating layers of various hues, and takes a fine polish —On the flooding of the Seine, and the means of preserving Paris from the overflow of the river, by M Belgrand With quays insubmersible by floods of a given height Paris might be preserved (1) from overflows of these floods, by prolonging the collecting sewers from the quays to the fortifications, isolating them completely from the river, and keeping them at their normal level by engines at the Clichy works, (2) from subterranean inundations, by means of a drainage lower than the submerged caves, and without communication with the river and the sewers, and maintaining the ordinary level with centrifugal pumps and turbines worked by the water of the city —M Colladon was elected correspondent for the section of mechanics, in place of the late M Seguin —New solution of the general equation of the fourth degree, by M Weichold New system of marine maps for navigation, by arcs of great circle by M Hilleret —Extraction of gallium from its ores, by M Lecoq de Boisbaudran —Action of zinc on solutions of cobalt, by M Lecoq de Boisbaudran He has sometimes met with considerable quantities of cobalt in the metallic sponge resulting from action of zinc on the solution of blende in aqua regia He notes the conditions of this singularity —Influence of carbonic acid on the respiration of animals, by M Raoult Slow chemical actions are generally limited by the presence of the products formed, if the latter are not liberated the reactions remain incomplete M Raoult verified by experiment on rabbits, that the presence of carbonic acid in inspired air diminishes the quantity of carbonic acid produced and especially that of the oxygen consumed in an hour in other terms, the presence of carbonic acid in inspired air is an obstacle to hæmatosis —On acetyl persulphocyanic acid by M de Clermont On the exchanges of ammonia between the atmosphere and mould, by M Schlœsing These preliminary experiments show distinctly that in general mould fixes ammonia from the atmosphere The supposed exhalation of ammonia during drought is, in all probability, an error it is the contrary that occurs On the oscillation of the hail of November observed at Nijni Novgorod, by M Babynine On the existence of mercury in the mineral state in the department of Herault, by M Thomas He has found it flowing abundantly from the ... a mountain called ... de ... in the canton of Ganges, also elsewhere A particular lichen is found in those parts —On the properties of the oysters called Portuguese, by M Champouillon These are from the Tagus and the north of the Tagu where they have great fecundity, occupying an extent of about 50 kilometres They have a claw like shell with small characteristic black point in ... and a dark fringe Analysis of the extracted oyster shows it to contain much more bromine and iodine than oysters on the English coast (0.05 ...) iodine and 0.052 gr bromine in ... of the animal substance, which contains ... of water and a slightly violet colouring matter It is a valuable food and is theoretically well suited for prevention of scrofula ganglionic swellings, rickets and perhaps ... phthisis ... oysters ... thrive on the coasts of Normandy, Belgium ... —Action of hydriodic acid on quercite, by M Prunier —Analysis of native magnetic platinum of Nischne Tagilsk (Oural) by M Terreil The considerable proportion of iron ... interesting —Anatomy of the heart of Crustacea, by M Dogiel (This forms part of a series of researches designed to throw light on the cause of rhythmic contraction of the heart in vertebrates) The ligaments of the heart in these animals do not play the direct physiological rôle that has been attributed to them, and the membrane which separates the heart from the liver, the digestive apparatus, and the genital organs of the lobster, is much more complicated and important that has hitherto been supposed, both as to structure and its rôle in the movement of the heart

CONTENTS PAGE

THURSDAY, MAY 25, 1876

LORD CARNARVON'S VIVISECTION BILL

THE Report of the Royal Commission appointed to consider the question of Vivisection has led to the introduction of a bill into Parliament, the clauses of which restrict the practice of experiments upon living animals to a very great extent. According to the act—

(1) Experiments must be performed with a view only to the advancement, by new discovery, of knowledge which will be useful for saving or prolonging human life, or alleviating human suffering.

(2) In a registered place.

(3) By a person holding a licence from one of her Majesty's principal Secretaries of State.

(4) The animal must, during the whole experiment, be under the complete influence of some anæsthetic, (not urari; and,

(5) Must be killed before it recovers from the influence of the anæsthetic.

(6) The experiment shall not be performed for demonstrational purposes; nor,

(7) For the purpose of attaining manual skill.

It is but natural to suppose that concomitantly with the rapid advances which have, within the last century or so, been made in our knowledge of scientific method, similar progress has occurred in the theory of legislation. And yet our leading politicians, in introducing the above quoted Bill, are bold enough to advance, as a motive for the legal machinery they are endeavouring to enforce, the idea that there is any real substantiality in the notion that the lengthening of human life and the alleviation of human suffering can form any direct stimulation to physiological work. In so doing they show how little they are capable of appreciating the spirit of the higher philosopher, whose thoughts and temptations to investigate, however much they may be disguised by secondary motives, are but the involuntary secretion, as it may be termed, of his individual brain. They do not even seem to know that one of the most fundamental of the data of scientific method precludes the possibility of preconceived ideas of any kind forming part of a correctly stated problem.

Next with reference to the licence which must, according to the Bill, be held by all who desire to practice vivisection, we cannot help feeling that any legislation which at all interferes with higher mental work is cumbersome in the extreme; for it appears to us to be quite unjustifiable to trammel in the least, the genuine and honourable exercise of original power, whatever way it tends to show itself. There can be no doubt that the genuine student of biology, in as far as he is a pure student, should be in no way restricted in his researches. The Duke of Somerset's objection also deserves special notice, for "important discoveries are often made by comparatively unknown men, rather than by the most prominent physicians and surgeons, and yet such students were to be prevented from prosecuting their researches."

With regard to educational physiology, quite a different influence is at work. We are among those who think that for the purpose of demonstrating physiological facts to students, vivisectional experiments are, notwithstanding the opinion of Sir James Paget and others to the contrary, not absolutely necessary. One of the physiologists examined before the Commission brought forward the case of the teaching of surgery in our medical schools, in which science the opportunities for obtaining independent practical skill on the living body are *nil;* and yet we cannot believe that many serious mistakes occur from the want of it.

Such being the case, the supervision of public institutions where physiology is taught is quite in accordance with our views, as are the restrictions with reference to the employment of anæsthetics, and the destruction of the subjects of experiment before they have recovered consciousness.

As to the exemption of Cats and Dogs, we never heard anything more ludicrous, and we are glad that Lord Winmarleigh—as a member of the Royal Commission his opinion is weighty—objected to the restriction as unnecessary. It may be true, as Lord Carnarvon remarked in the House last Monday night, that the employment of these animals has slightly encouraged theft in their direction; but that this should be, by sober men, accepted as a reason for taxing physiologists to purchase more expensive animals, when a few more stringent sentences in the police courts would remove the evil, seems feeble in the extreme.

Looking at the Bill from a general point of view, its great defect is, in our estimation, its separate existence. The genuine spirit which actuates our nation, if we are not mistaken, is one which looks with disgust at the infliction of pain when unattended with the highest advantages. That this is not the case in some foreign countries we know, and can more fully realise since Dr. Klein has given his evidence before the Royal Commission. No doubt, as Lord Carnarvon remarked, "students are more and more in the habit of frequenting foreign Schools and returning to this country with the traditions and modes of these Schools." Would not a clause or so attached to the previously existing Cruelty to Animals' Act, however, cover all the requirements of the case by enabling an inspector, or a private individual, to prosecute any one performing a vivisection for simple demonstration purposes, or if he publishes results which show that due precaution has not been taken to reduce pain to a minimum in the animal operated on?

WILSON'S "PREHISTORIC MAN"

Prehistoric Man: Researches into the Origin of Civilisation in the Old and the New World. By Daniel Wilson, LL.D. Third Edition. (Macmillan and Co., 1876.)

DR. DANIEL WILSON claims the merit of having introduced the useful term *prehistoric*, first employed (he says) in 1851, in his "Prehistoric Annals of Scotland." There its meaning was limited to races preceding the oldest historical nations of Northern Europe. But in the first edition of his "Prehistoric Man," published in 1862, it had become a general term for tribes ancient or modern in chronology, as to whom

written history fails to afford information, and who are only known through archæology. The adoption of the word by Sir John Lubbock in the title of his "Prehistoric Times," published in 1865, and its incorporation into the name of the "Congress of Prehistoric Archæology," which held its first meeting at Neuchâtel in 1866, brought it into general currency.

The present third edition of Dr. Wilson's "Prehistoric Man" contains the principal dissertations of the original work. These are especially the account of the earthworks of the mound-builders of Western America, of the native-copper mines worked by the indigenes in the Lake Superior district, the details of stone and shell implements in America, and studies of American craniology The book has been now expanded so as to bring the new European evidence into connection with the American investigations, and in the course of correcting various rash statements made in the previous editions have been pruned away. It is of course not necessary to go over the contents as though the work were new, but the following are among the points calling for remark :—

Living at Toronto as Professor of History at the local University, and having had special opportunities of studying the indigenes of North America and their antiquities, Dr. Wilson sees the problems of general ethnology from a peculiar point of view, which is often an advantageous one. For instance, as an archæologist living within reach of the above-mentioned native copper workings of Lake Superior, he was naturally led to give due attention to the interesting intermediate stage here represented between the Stone Age proper and the Metal Age proper. The tribes of the district had got so far as to discover that the copper they found in blocks was a malleable stone of great value for making hatchets and other tools of, but they had not arrived at the next stages, those of learning to smelt copper from the ore, and to alloy it with tin. Such an intermediate stage may possibly have at some time existed also in the Old World (vol. i., p. 230). Dr. Wilson's remarks are interesting both on the use of native copper among the northern tribes of the continent, and on the manufacture of bronze in Mexico and Peru. But the author's American surroundings perhaps incline him to ascribe too readily to the native tribes an absolute independence in the development of their civilisation, uninfluenced during historic centuries (as he says) by any reflex of the civilisation of the Ancient World. We do not think that he ought to have assumed (vol. i. p. 224) that the art of bronze-making was developed in the native-born civilisation of Mexico and Peru. He seems to recognise (vol. ii. p. 60) Humboldt's argument, that the Mexican astronomical calendar came from Asia, and if so, why should not the art of bronze-making have come thence too, and at no very ancient date? Dr. Wilson himself points out the likeness between the mirrors of polished bronze found in the royal tombs of Peru and those now in use in Japan (vol. i. p. 244).

There are two assertions often made as to the inhabitants of the part of America with which Dr. Wilson is well acquainted. One is that the skull and face of the English race in the United States are becoming assimilated to the type of the North American Indians. On this Dr. Wilson's remark is simply negative: "I can scarcely imagine anyone who has had abundant opportunities of familiarising himself with the features of the Indian and the New Englander, tracing any approximation in the one to the other" (vol. ii. p. 329). The other assertion touches the intellectual powers of the Negro as compared with the white race. For instance, Sir Charles Lyell was told in Boston (as many other Englishmen have been) as a reason for the coloured children being taught separately from the whites, that although up to the age of fourteen the Negro children advanced in education as fast as the white children, after that point it became difficult to carry them on further. Dr. Wilson regards this statement as a mere excuse, intended to justify a separation really made through caste-prejudices (vol. ii. p. 325). Dr. Wilson's testimony is of consequence on these two points, which rest on so considerable authority, that they ought without delay to be settled one way or the other. We can only hope he will find time to go more fully into them, considering their importance as throwing light on climatic modification of race on the one hand, and intellectual difference between races on the other.

Dr. Wilson is evidently more critical as an ethnologist and antiquary than as a comparative philologist. It is a pity that among the new matter inserted in this edition, he should have put in a passage which may lead uninstructed readers to believe that a connection has been really made out between the Guarani of Brazil and the Agaw of the Nile region, or between the Akkadian of Babylonia and any American language (vol. ii. p. 346). Dr. Wilson mentions certain theories propounded by Mr. Hyde Clarke, but he does not even produce the evidence on which he relies. On the contrary, it may be said with some confidence, that as yet no philologist has proved any prehistoric connection whatever between any language of America and any language of the Old World, except of course, near the shores of Behring's Straits.

In fairness to Dr. Wilson, however, the value of other of his linguistic contributions must be acknowledged ; for instance, his list of imitative names of animals in Algonquin dialects, and his remarks on the Chinook jargon, and the *Pigeon*-English (*i.e.* *Business*-English) of the Chinese ports. The specimen of the latter (vol. ii. p. 333) is the introduction of a new English customer to a Chinese merchant :—"Mi chinchin you, this one velly good flin belong mi ; mi wantchie you do plopel pigeon along he all same fashion along mi," &c. On the whole Dr. Wilson is to be congratulated on the reappearance and revision of his work.

EDWARD B. TYLOR

THE ARALO-CASPIAN REGION

The Shores of Lake Aral. By Herbert Wood, Major R.E., F.R.G.S., &c. (London : Smith, Elder and Co., 1876.)

FROM the earliest times down to the present day there has always been a certain amount of mystery and uncertainty hanging around the Aralo-Caspian region. Major Wood in the work before us shows that the physical history of this ever-changing region is largely sufficient to account for this mysterious halo. Major Wood had an unusual opportunity for exploring Lake

Aral and the regions around it in 1874, having been allowed to accompany an expedition sent out under the auspices of the Russian Geographical Society to examine the Amúdarya. The results of this visit, as contained in the masterly work under notice, show that he took excellent advantage of so favourable an opportunity. Some of the most important of these results as regards the past and present physical condition of the Aralo-Caspian region were described by Major Wood in three papers which appeared in NATURE, vol. xi. p. 220, and vol. xii. pp. 51 and 313. To these papers we would refer those who want to get a succinct idea of some of the important conclusions which Major Wood has reached; but all who take an interest in physical geography generally, and this region in particular, we would advise to procure the work under notice.

The two main points discussed by Major Wood are the past and present condition of the Amúdarya or Oxus, and the existence at one time of a great Asiatic fresh-water Mediterranean Sea, of which the Black Sea, the Caspian, and Lake Aral are only remnants, and having communication by the region to the north of the last-mentioned lake with the Arctic Ocean. How small a change in the present conditions of the Black Sea would serve to give rise to such a great inland sea as Major Wood, on good grounds, supposes once to have spread its waters over a wide extent of Asia and Europe, may be seen from the following extract:—

"Supposing the outlet of the Bosphorus to be closed to the height of two hundred and twenty feet above sea-level, the superfluous waters of the Black Sea basin, which now flow off to the Mediterranean, would rise in level and encroach on the south Russian steppes and the lower Danube plains, though the coasts of Asia Minor, which form the southern boundary, would be but little changed on account of their steepness. On attaining a height of about twenty-three feet above sea-level[1] the waters would escape by the line of the Manytsch into the basin of the Caspian, and, after having filled it up also, would flood the country intervening between it and Lake Aral. In their ascent to this basin the waters would chiefly pass by the Emba steppes from the north-east of the Caspian basin, and from Balkhân Bay on the south-east, up the country crossed by the Uzboy channel of the old Oxus; for between the two seas lies the elevated plateau of Ust-Urt. This high ground has several detached portions near the Caspian shore, while the remainder of its surface is covered with numerous bowl-shaped depressions. These would, in all probability, have received the rising waters by ravines which enter the body of Ust-Urt from the low steppes upon its north and upon its south, and the aspect of the plateau would thus have been changed into that of the lake and marsh sprinkled highland whose traces remain to-day.

"In this imaginary reconstruction of the Asiatic Mediterranean, the moment the rising waters reached a point at about two hundred and ten feet above the sea, and which is situated at the head of the now dry gulf Abougir, they would have entered into and filled up the basin of Lake Aral."

Many indications exist at the present day pointing to the great probability of the existence, at some perhaps not very remote period, of such an inland sea. The fauna of the basins of the Black, the Caspian, and the Aral Seas are nearly identical; a glance at the fine map which accompanies the volume shows that the region to the north of the Aral is covered with lakelets, and evidence exists that in historical times the Aral was joined to the north part of the Caspian. The amount of evidence, historical and physical, produced by Major Wood in support of the ideas developed in his work, is very great, and we think in the main convincing.

The author devotes a number of chapters to the Amúdarya, the lower course of which he has explored with the greatest minuteness; indeed he seems familiar with every mile of it. He gives a clear and detailed account of the lower arms of the Amú—which are not at all of the nature of a delta by which it discharges itself into Lake Aral. No dependence can be placed on the permanence of these outlets, nor indeed it would seem upon that of any part of the Amú for the last 400 miles of its course. It is known that at one time it flowed into the Caspian, and Major Wood's work and map show how this could easily have been, and could easily be again brought about at the present day. From Tchardjui an old bed is seen to strike westwards to the Balkhan Bay of the Caspian, and from this branch again Major Wood adduces evidence to prove that, periodically at least, another must have struck south-westwards into the Attrek, which has been so much in the front recently. The Amú, indeed, throughout historical and no doubt prehistorical times, has been an ever-changing river, in its lower course at any rate; its frequent and perplexing changes being caused partly by the physical conditions which regulate its flow, and partly by the interference of man; for at the present as in past times the river is tapped at several places for the purpose of irrigating the desert regions which lie to the west. The river divides at Khodjeili into three main branches, which carry its water to Lake Aral; but these seem to be ever shifting, and the region embraced between them, inhabited by the poor Karakalpaks, seems to be mostly a swamp.

Major Wood also devotes some space to an account of the Syrdarya or Jaxartes, which at one time discharged a considerable proportion of its waters by the Jany Darya into the Amú, and thus probably ultimately into the Caspian. Major Wood traversed the district between the lower Amú and Fort Perofisky, the Kizzel Koom desert, and came across distinct traces of a former channel. But altogether the amount of evidence, historical and physical, which he brings forward to show the changes which have taken place in the region under consideration is almost bewildering. Greek, Arabic, Russian, and Chinese writers of all ages are quoted; indeed Major Wood seems to have collected every important scrap of writing that bears on the region he is investigating. This historical evidence, combined with the physical conditions of the region with which he has made himself thoroughly familiar, enable him to make out a strong case on behalf of all the points he desires to establish. The work must always be regarded as a standard reference-book on the hydrography of the Aralo-Caspian region. But it is something more; notwithstanding that it endeavours to solve some very hard questions, it is never dry, never uninteresting. It contains a record of a pleasant and profitable journey from Samara on the Volga to the Russian ports on the Syr, a

[1] This is the height of the surface of the lake, which exists in the bed of the Western Manytsch, at its higher extremity, though the level of the banks, at the bifurcation of the Eastern and Western Manytsch channels, is more. M. Hommaire de Hell stated this height to be nearly ninety feet above the sea, which is not very incorrect, though perhaps slightly in excess of reality.

cruise down the Sea of Aral, and up the Amú, and, as we have said, a journey across the dreary desert of Kizzel Koom. Major Wood conveys, we think, a clearer and more vivid idea of the region indicated, its aspects, and its inhabitants, their characteristics and habits, than any other author we know. The maps which accompany the volume are a great assistance. We may note that they give the present level of the Caspian as 85 feet below that of the ocean, Lake Aral being 158 feet above sea-level. This, we presume, may be taken as authoritative for the present, and it ought to be noted, as the statements on the point in various authorities differ in a most remarkable way.

Major Wood naturally speaks of the conduct of Russia in Asia with warm approval, and indicates several beneficial results which have followed her recent conquests. He believes that of all European powers she, partly from the simplicity of her Government, and partly on account of her ethnic affinities, is best suited to wean the wandering hordes of Central Asia to a settled and civilised life. We strongly recommend Major Wood's work as one of substantial value and great interest. But why has a work of such importance and so full of details, been allowed to go forth without an index. We hope this omission will be remedied at the first opportunity.

OUR BOOK SHELF

La Théorie des Plantes Carnivores et Irritables. Par Edouard Morren. (Bruxelles: F. Hayez, 1876.)

In this pamphlet, a report of an address given at the annual public meeting of the scientific section of the Royal Academy of Belgium, on Dec. 16, 1875, Prof. Morren gives an admirable *résumé* of the present state of our knowledge on these two branches of vegetable physiology. As regards the now well-known phenomena of carnivorous plants, he gives the most essential points of the observations of Darwin, Hooker, Lawson Tait, Reess and Will, the author himself, and others: and, in contrast to his relative, M. Charles Morren, he gives his full adhesion to the view that nitrogenous substances are actually digested by the leaves of *Drosera*, *Pinguicula*, and *Nepenthes*. He points out, indeed, that the theory is not a new one, having been promulgated by Burnett in 1829, as respects *Sarracenia;* and by Curtis in 1834, and Canby in 1868, as to *Dionæa;* and also, he might have added, by Dr. Lindley, in his "Ladies' Botany," published in 1834. In his introductory remarks Prof. Morren insists on the identity of the process of nutrition in the animal and vegetable kingdoms. The second portion of the discourse is devoted to the elucidation of the phenomena of "Motility" as exhibited in the irritability of the leaves of *Mimosa*, the stamens of *Berberis*, and other organs which exhibit similar peculiarities; the aggregation of protoplasm as seen in the "tentacles" of *Drosera;* the apparently spontaneous movements of zoospores, climbing plants, &c. Anyone desiring to obtain a general idea of what is at present known on these interesting subjects could not do better than consult Prof. Morren's lecture. It is pleasant to find a tribute to "la science Anglaise" in connection with vegetable physiology.

A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Supposed New Laurentian Fossil

When a man finds that he has made a mistake, the best thing he can do is frankly to acknowledge and explicitly to correct it.

I lose no time, therefore, in making known to the readers of Nature that the notice of a New Laurentian Fossil which I published in its columns three weeks since, was written under a complete misapprehension of the real nature of the body. So far from being calcareous, as I had been led to believe by the information I had received from the geologist who found the specimen, it proves to consist of alternating layers of felspar and quartz—the former simulating an organic structure like that of *Stromatopora*, and the latter occupying what had been supposed to be the cavities of that structure—together constituting what is known to petrologists as "graphic granite."

The conclusions I had drawn from a cursory examination of the sections first sent me by Mr. Thomson, instead of being confirmed by a more minute study of thinner sections, proved to be altogether untenable; what I had supposed to be piles of flattened chamberlets in the thickness of each lamella, turning out to be mere fissures in the felspar, arranged with extraordinary regularity; and what had seemed to be a vertical tubular structure, proving to be mere striation.

The examination of numerous sections of this body, and a comparison of them with sections of the "graphic granite" found in its neighbourhood, has now satisfied me that the former presents no other indication of organic origin, than is afforded by the *Stromatopora*-like disposition of its alternating lamellæ; and that this is so nearly approached in the latter, as to show that the agencies which produced the "graphic granite" were competent to have produced the supposed Harris fossil.

Whether these agencies were entirely inorganic, or whether the "graphic granite" itself may not be a metamorphic form of an ancient organic structure (metamorphoses nearly as strange having undoubtedly happened), is a question which is not at present to be decided by anyone's *ipse dixit*. When a petrologist shall have succeeded in *making* a graphic granite, he will be entitled to speak with assurance of its purely mineral nature.

It will doubtless be triumphantly urged by those who maintain *Eozoon* to be a "pseudomorph," that as I have had to confess myself completely mistaken in regard to the Harris specimen, I am just as likely to have been wrong in regard to the Canadian ophicalcite. To this I have simply to reply that my mistake in the present case has arisen entirely from undue haste, and has been corrected by my own more careful study; which has satisfied me of the *entire absence*, in the Harris specimen, of those Foraminiferal characters which seem to me unmistakably recognisable in the Canadian *Eozoon*.

In the memorable discussion at which I was present in Paris, on the flint implements found associated with the Abbeville jaw, it was the *entire absence*, on the surface of those worked flints, of the staining, the dendrites, the patina, and the wearing of the edges, characteristic of the genuine implements, which satisfied the English experts of the factitious character of the former. But, so far from anyone being led by this discussion to call in question the fashioning of the genuine implements by men coeval with the river-gravels of the Somme, it only brought out more fully the strength of that case, by showing what complete reliance might be placed upon the characters of antiquity which they presented. And so, in the present instance, the striking contrast in the microscopic appearances presented by two bodies bearing a close resemblance in general structure, seems to me only to bring out the organic characters of the one more decidedly, by comparison with the purely mineral characters of the other.

William B. Carpenter

Theory of Electrical Induction

I was hoping someone of eminence would tell us what he thought of the arguments of Prof. Volpicelli, or whether no clearer view of induction had been arrived at. Prof. Clerk Maxwell's letter of last week brings back the subject to its natural point of view to one whose ideas are based upon potential, but at the same time it leaves some points doubtful which have a particular bearing on the whole theory. Might I therefore be allowed to ask information from him, by explaining the ideas which have been impressed upon me about this, by reading his book "Electricity and Magnetism," though they are removed *toto cælo* from the ideas expressed by the phraseology of Prof. Volpicelli, and that of the usual text-books.

We know nothing of electricity except as a force. We may speak of it as a fluid, and use a corresponding terminology, but it is always measured as force. A conductor is a body in which

these forces immediately equilibriate themselves at the expense of calling into play other forces of the same or of opposite kind amongst the molecules of the dielectric. These forces give rise to the diminishing potentials as they are equilibriated over greater and greater surfaces. When another conductor is brought into the neighbourhood, since throughout it the electrical forces are in equilibrium amongst themselves, the various molecular forces are as before manifested only at the surface, and they are necessarily negative where the conductor obtrudes into regions of higher positive potential than its own mean, and positive where it lies in the regions of lower positive potential. But not only this, the molecular forces which keep the electrical forces in the dielectric in equilibrium cannot thus simply be pushed, as it were, backwards and forwards, but must fall into equilibrium in their own way—in other words there is a redistribution of electricity both on the inductor and inducer, which can only be determined by properly drawing the equipotential surfaces corresponding to the new arrangement (if possible). The state of stress of the particles of the dielectric surrounding any small conductor is not affected by its total motion of translation, except that as it is moved from the other conductors it is redistributed on the surface.

If now we draw a series of equipotential surfaces, that particular one which corresponds to the potential of the conductor will divide it, as Prof. Clerk Maxwell says, into two parts, on one of which is negative electricity, and on the other positive, in other words the state of stress of the particles outside the conductor is of one kind on one side, and of the opposite kind on the other. Now comes my first question. If this is the case how can it be said that there is either more positive electricity on the inducer nearest the inductor as Prof. Clerk Maxwell says, or less as Prof. Volpicelli says, than at the other end, when in fact there is none, but the force is negative? No doubt we can take for mathematical purposes a negative quantity as the sum of two others, one positive and the other negative and greater, but can the existence of the positive quantity be called a "fact" in consequence?

There is a way, however, in which we might be inclined to say that the positive electricity is least nearest the positive inductor, but this looked at in the same way as before, raises a second question. If we make a small conductor touch any part of the induced conductor, and then try it in the usual way, we might say that the spot on which we touched it when the small conductor was most electrified had the greatest amount of electricity upon it, and might determine its kind. But before doing this we ought to ask what will be the effect of bringing the new conductor into the neighbourhood, and this depends on its shape and size. The equipotential surfaces will all be altered, and the alteration may be such that the one belonging to the first induced conductor may leave the new one entirely on the positive or entirely on the negative side, or may divide it into two like the first induced conductor. In connecting with the earth we make the new conductor so large that the old one is all on the negative side; and the fact that by breaking contact we can keep the old conductor charged with negative electricity shows that we may take any smaller part from the wholly negative side and it will also show the same electricity, as in inductive machines. If the new conductor be so shaped or so large that it cuts through the neutral equipotential surface, on removing it only the balance of the forces called into play will be left to be equilibriated by the molecular forces, and that balance may be positive though the contact was on the negative side of the former neutral surface. In this way only could a finite conductor take positive electricity from the negative side, but in this case it is due to induction on the new conductor as temporarily forming part of the old, and not to the original induction on the first conductor. What experimental proof, then, is there, or can there be, if these principles are true, that there is *any* positive electricity nearest the positive inductor before the distribution is disturbed by too long or large a conductor being brought into the field? and how, therefore, is Melloni's theory true?

Also, might not a point if properly placed on the negative side, cut through the neutral equipotential surface and so discharge positive electricity?

I should be glad to know, from a good authority, that we may thus explain these phenomena by a reference to force alone and not to hypothetical fluids, and without meddling with such useful, perhaps, but unmechanical ideas as "bound" and "free."

J. F. BLAKE

Dynamometers and Units of Force

IN NATURE (vol. xiv., p. 29) Prof. Barrett says "it would be interesting to know on what grounds Prof. Hennessy bases his emphatic and reiterated assertion." The assertion referred to is contained in my former communication (NATURE, vol. xiii., p. 466). The grounds on which it is based are as follows:—In order to accurately measure units of force according to the C. G. S. system, spring balances which could be depended upon to the $\frac{1}{981}$ of a gramme or $\frac{1}{63}$ of a grain nearly would be required. In mechanics the forces to be compared and measured usually amount to several kilogrammes, and powerful spring dynamometers are most suitable for their estimation. Dynamometers such as those alluded to as being sent for exhibition from the College of Science to South Kensington are of this kind. By experiment I have found them unfit for the estimation of small units of force. I should be much interested in seeing Prof. Barrett or Dr. Ball measuring a C. G. S. unit or $\frac{1}{981}$ of a gramme by the aid of one of these dynamometers. It should be remembered that in this discussion I all through refer to these dynamometers and others of a similar kind employed in mechanics. I was already aware of the belief expressed by Sir William Thomson and Prof. Tait, that spring balances, "*if* carefully constructed," would rival or even surpass the ordinary balance. While thus referring to the possible perfection of the spring balance with the qualifying particle "*if*," they justly remark that the pendulum is the most delicate of all instruments for the measurement of force. A pendulum will probably always furnish the best means for measuring force in absolute measure, whether by large or small units; and I entertain strong doubts as to whether the spring balance can ever supersede the beam balance for accurate determinations of weight. In no department of experimental inquiry are such minute quantities weighed, and nowhere is greater accuracy in determining differences of weight required than in chemical analysis, and chemists almost universally employ the beam balance in preference to the spring balance in their most delicate analytical researches.

In my former communication I mentioned that the dynamometers alluded to could not be depended on within the tenth of a kilogramme. In saying this I have spoken of them in the most favourable terms, for the larger one can scarcely be depended upon within the fifth of a kilogramme.

Prof. Barrett quotes a statement as "occurring in Prof. Hennessy's own syllabus," which implies that I had adopted and used the C. G. S. system. The words quoted belong to a syllabus written by Dr. Ball for the session 1874–75. I entered on my duties after the commencement of that session, and my name was attached to new editions of the syllabus instead of the name of its author, while the part of the syllabus relating to mechanics remained untouched. I had been always under the impression that Prof. Barrett was perfectly aware that I was not the author of this syllabus, and although technically it might be regarded as the syllabus of applied mathematics in the College until a new one could be prepared and published with the sanction of the Science and Art Department, it seems scarcely correct in a scientific discussion to quote it as expressive of the views of a person who was well known not to be its author.

Prof. Barrett, in his first letter, laid much stress on the introduction of spring dynamometers into Dr. Ball's courses on mechanics for the estimation of force in absolute measure; as if such an employment of these instruments was entirely new. It is but just to observe that dynamometers of the same kind, and graduated in the same way, have been long since employed in other courses of mechanics, and such instruments are figured and described in some of the most common elementary books used in the colleges of Europe. With reference to the dynamical units which I prefer to employ in my courses of mechanics, Prof. Barrett uses the phrase, "a mixed system of kilogrammeters and foot-pounds." I never mix the two kinds of units. I keep them perfectly distinct. I employ both, because in the practical applications of mechanics, students may be called upon to apply one or the other. As far as I have been able to ascertain, these are the units in most general use among engineers throughout the world; and I should as soon expect mechanicians to adopt the C. G. S. system as to hear that bankers adopted our smallest coin as the unit of account instead of the sovereign, and to see the prices of stocks in the money market no longer quoted in pounds but in farthings.

HENRY HENNESSY

Royal College of Science for Ireland

THE POTATO DISEASE[1]

II.

THE Peronosporeæ are usually divided into two genera, viz.—Cystopus and Peronospora: with the former the potato disease has no connection.

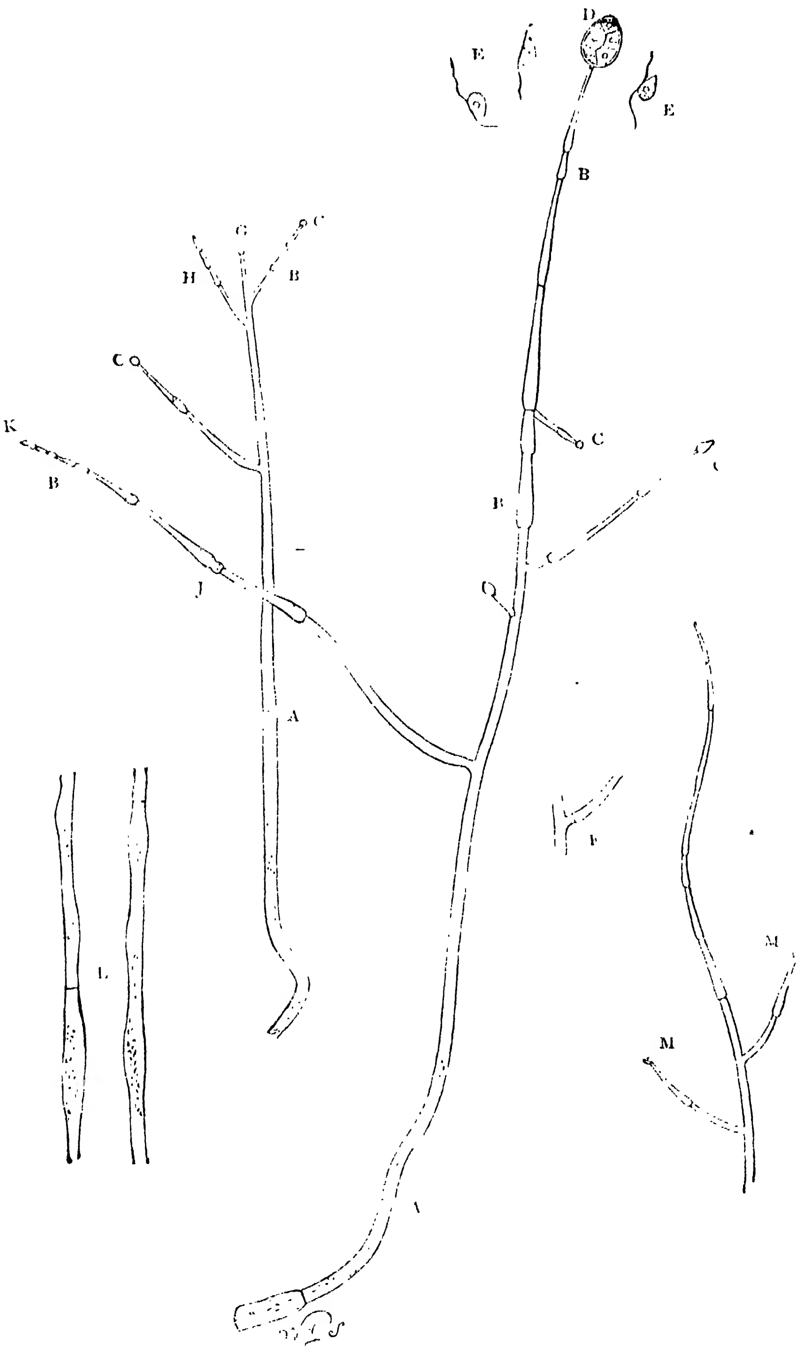


FIG. 7.—*Peronospora infestans*, Mont., × 250 dia. From De Bary's slide, No. III. A, A, septate conidiophores; B, B, vesicular swellings; C, C, immature conidia; D, conidium, showing differentiation of its contents; E, E, free zoospores; F, frequent mode of attachment of branch.

II.—PERONOSPORA, *Corda.*

The fungus of the potato disease was first placed under the genus Botrytis Mich., but Corda established Peronospora to receive the species with non-septate threads. Unfortunately for the genus, and for *P. infestans* in particular, the threads of the latter are always more or less septate, and this character effectually separates the potato-fungus from the *Saprolegnieæ* (as at present defined) where septa are unknown. De Bary now proposes the establishment of another new genus (under the name of Phytophthora) to receive the potato-fungus, the chief character of the proposed new genus resting on the development of, not one, but several spores (conidia) successively at the end of each branch of the aerial threads of the fungus (conidiophores). This character has been known to fungologists since the potato-fungus was first described, although it has generally been esteemed of specific rather than of generic value. The Rev. M. J. Berkeley in illustrating the potato-fungus for the Royal Horticultural Society, figures the conidia as being pushed off the branches (Pl. 13. Fig. 12*, 14). The same phenomenon is illustrated in the Micrographic Dictionary (Pl. 20, Fig. 6). I have also recorded the habit in the secondary condition of the fungus where the oogonia are successively pushed off the supporting threads.

As so much attention has of late been directed towards the Peronosporeæ it is more than ever necessary that the characters of the family should be correctly known, and this is especially important as regards the nature of the secondary state of these fungi: a brief statement of the sexual condition may therefore be useful. The female cells (oogonia) are borne sometimes on the tips of mycelial threads, sometimes as sessile bodies on different parts of the threads and sometimes intercalated within the threads themselves, after the manner of the illustrations on Figs. 1, 3, and 4. The male organs (antheridia) are usually smaller and carried on finer threads, not as a rule anatomically distinct from the oogonium-bearing threads. The contact of the antheridium with the oogonium, gives rise to the oospore or resting-spore.

Peronospora infestans, Mont., in its aerial state has been so often and so accurately described by Berkeley, De Bary, and others, that any further illustration or description is almost unnecessary. It must be confessed, however, that the figures first published by Messrs. Berkeley and Broome (in connection with Dr. Montagne) and latterly by De Bary, have only too many times been copied and recopied without reference to the fungus itself. There is therefore no apology required for publishing the present illustration (Fig. 7) which is new, and I trust exact. It is a camera lucida reproduction enlarged 250 diameters of a group of conidiophores as supplied by Prof. A. De Bary

[1] Continued from vol. xiii., p. 527.

to the Royal Agricultural Society, on their Slide No. III. (The three free zoospores are from a drawing by De Bary.) The septate aerial branches of the fungus, named conidiophores are seen at A A. The characteristic vesicular swellings peculiar to the potato-fungus at B B. Immature conidia at C C, and mature conidia at D, the latter showing the contents differentiating into zoospores. The zoospores are shown free at E E. The mycelium and conidiophores of *Peronospora infestans* are generally furnished with septa (A A) but this character is liable to great variation. The conidia are at first terminal (G) with no swelling on the thread below, but as the threads grow they push off the old conidia and continue to produce new ones on each newly formed apex. De Bary explains this phenomenon by saying, "When the first conidium is ripe, it is pushed to the side by an unequal swelling of the point to which it is attached. The top of this swollen portion then begins to grow in the original direction of the branch into a new conical point; and when this has reached a length equal to that of a conidium, or a conidium and a half, a new conidium is produced at the apex." I take this to be only partially correct, for the more reasonable explanation of the vesicular swellings on the threads is that the thread is constantly making an effort to produce new conidia, and each swelling is really an *abortive conidium*: each of these pieces will grow in water if free, as will the immature dust-like conidia (C C) the latter are being pushed off at M M. On looking at point B, it will be seen that the swellings there illustrated have never produced terminal conidia at all, but that each successive swelling is in itself an *attempt* to become one. Instead of these bodies *when terminal* growing to the length of "a conidium or a conidium and a half" they commonly remain the mere fourth or sixth part of a conidium in length, and often less, and never produce conidia. At J will be seen a double swelling: the first effort of the thread fell short, and the attempt to produce the conidium was renewed: such double swellings are common; a terminal one occurs at K. Vesicular swellings occur on all parts of the conidiophore; they are frequent at the base, commonly irregular as at L and always (to me) represent an attempt at fruit production.

It may just be well to remark that the suggestion as to the possibility of the oospores of *P. infestans* being ultimately found on some plant different from *Solanum tuberosum* is very old, and that Mr. Berkeley has recently found the potato-fungus growing upon the garden Petunia, this plant, we believe, has not been given in any previous list, and its importance must not be overlooked, for the Petunias come from the native country of the potato, one garden species even coming from Chili.

Prof. De Bary is not right in his surmise that he was "perhaps" the first to call attention to the perennial mycelium of the potato-fungus in 1863; Mr. Berkeley did this in 1846 and the fact has been confirmed by many observers since. The subject is thoroughly old and is discussed in our popular books; for instance—see vol. xiv. of the "International Series" Fungi (p. 156), where Dr. M. C. Cooke says, "The Peronospora of the potato is thus perennial by means of its mycelium." Most fungi depends for their existence upon "perennial mycelium." The "spawn" of the common mushroom is a good and well known example. A mycelium may however be perennial and yet produce oospores.

WORTHINGTON G. SMITH

OUR ASTRONOMICAL COLUMN

THE OCCULTATION OF SATURN, AUGUST 7, A.M.—Perhaps some observers who are provided with good telescopes may be induced to look for the occultation of the planet Saturn, on the morning of August 7, although (in the south of England) the immersion does not take place until half an hour after sunrise, and at emersion Saturn is only some five degrees above the south-western horizon.

Reference is made to the phenomenon here with the view to illustrate the use of the method of distributing predictions over a given geographical area, explained by Mr. W. S. B. Woolhouse in the *Companion to the Almanac* for 1871, as applicable to the phases of a solar eclipse, to the approximate prediction of the times of immersion and emersion of a star or planet in a lunar occultation, and the angles on the moon's limb at which they occur, at any place within the given area or very near to it. It is founded upon the assumption that the value to be determined is a linear algebraic function of the latitude and longitude of the place, for which the calculation is to be made. On this assumption the time (t), of any phase, &c., may be expressed thus:—

$$t = c + p.L + q.M.$$

where c, p, and q are three constants to be found.

If now direct calculations of the particulars of any phenomenon be made for three places moderately distant as Greenwich, Dublin, and Edinburgh, the constants will be determined by the substitution of the results, which supply the three equations of condition necessary. If the difference Greenwich—Dublin be called h, and Greenwich—Edinburgh k, then, as calculated by Mr. Woolhouse:

$$p = 0·1425\,h - 0·2840\,k$$
$$q = 0·05014\,h - 0·0213\,k$$
$$c = G - 1·4772\,k.$$

G being the result of the computation for Greenwich.
Also L is latitude − 50°, expressed in degrees and decimals.
And M is longitude from Greenwich, + if east, − if west, in minutes of *time* and decimals.

Applying this method to the occultation of Saturn we have, by direct computation for Greenwich, Dublin, and Edinburgh (astronomical times at Greenwich, Aug. 6).—

	Immersion.	Emersion.		Angle N Pt Immersion	Angle N Pt Emersion
	h m	h m			
Greenwich	17 7·3	18 3·10	..	94·0	331·1
Dublin	17 0·25	18 2·35	..	107·0	319·0
Edinburgh	17 0·25	18 2·38	.	111·2	313·6

The necessary data being taken from the *Nautical Almanac*, and the angles expressed as usual in that work.

Thus we find for Greenwich time of immersion and emersion at any place in this country, and for the angles on the moon's limb from north point

		h m	
Immersion	Aug. 6	17 0·05	[illegible] L [illegible] M.
Emersion	„	18 3·24	[illegible] L [illegible] M.
Angle Imm.		90·3	[illegible] L [illegible] M
Angle Em.		330·3	[illegible] L [illegible] 0·2 M

The differences between the results of these equations and direct calculations for Exeter and Liverpool are:—

	Exeter.	Liverpool.
	m	m.
Immersion	0·2	+ 0·2
Emersion	0·1	0·3
Angle Imm.	+ 0·3	0·2
Angle Em.	0·1	+ 0·1

In this manner have been derived the following particulars, as regards the occultation in question, which will illustrate the applicability of Mr. Woolhouse's method to such phenomena:—

	G.M.T. of Immersion	G.M.T. of Emersion		Angle from N. point Imm.	Angle from N. point Em.
	h m.	h m			°
Aberdeen	16 59·9	18 2·4	..	113	310
Cambridge	17 6·9	18 3·0		99	329
Exeter	17 5·6	18 2·7	..	96	. 331
Glasgow	16 59·4	18 2·3		112	. 312
Liverpool	17 2·8	18 3·0	.	104	. 322
Manchester	17 3·6 .	18 2·7	...	103	322
Nottingham .	17 5·9 ..	18 2·9	..	99	. 326
Oxford	17 6·1	18 3·0	.	97 .	329
Portsmouth	17 7·3 .	18 3·1		94	. 332
York	17 4·9	18 2·8		102	322

NEW RED STAR.—Mr. Birmingham, Millbrook, Tuam, mentions (*A. N.*, 2,092) his having remarked an intensely red star, 8·5 magnitude, which is not in Schjellerup's catalogue (*Vierteljahrschrift der Astron. Gesellschaft*, ix. Jahrgang, Heft 4). From the approximate position given the star appears to be No. 3,168, + 36° in *Durchmusterung*, where it is also estimated 8·5, and its position 1855·0 is R.A. 18h. 27m. 19s., N.P.D. 53° 7′. It has not been found in any other catalogue.

THE DOUBLE STAR Σ 3,121.—This object well merits the attention of observers who are in the possession of large telescopes. Baron Dembowski seems to have given it up for the present as beyond his instrumental means. It is evidently a binary of no long period. For comparison we have—

Struve ..	1832·31	Position	20°·0	Distance	0″·85
Dembowski..	1866·22	,,	180·7	,,	0·68
,,	1872·23	,,	210·5	,,	a wedge
,,	1875·31	,,	252·0	,,	oval.

The place of this star for 1876·0 is in R.A. 9h. 10m. 32s., N.P.D. 60° 53′·8.

THE LOAN COLLECTION CONFERENCES.

THE work in connection with the South Kensington Conferences has been carried on heartily and successfully during the past week. The number of visitors to the collection has been, all things considered, satisfactory, and the conference-room is always well filled.

Of the papers in the Section of Mechanics read on the 17th inst., M. Tresca's, on the "Flow of Solids," possessed some novelty and interest. From his experiments he drew inferences as to the proper form and mode of application of tools, explained the theory of many of the adjustments which workmen have found out by rule of thumb, and indicated extensions of the use of the principles now reduced into formulæ. He added that, in his belief, these mechanical laws ought to be pursued into physiology, and that the accretion of cell to cell was a mechanical phenomenon.

The conversazione given by the Physical Society the same evening was brilliant and successful.

At the meeting of the Chemical Section last Thursday, Dr. Frankland gave a long and highly important address, mainly on eudiometric apparatus. This address we give this week *in extenso*. Dr. J. H. Gilbert, F.R.S., then gave an interesting lecture on "Some Points connected with Vegetation." Mr. W. F. Donkin, M. A., then gave a description of the ozone apparatus of Sir B. Brodie, Bart., F.R.S., after which Prof. Andrews, F.R.S., concluded the meeting with an account of some experimental investigations in connection with the physical constitution of gases.

On Friday was held the second Conference in connection with the Physical Section. The conference-room throughout the day was unusually well filled. The first communication was from Prof. Tyndall, F.R.S., on the "Reflection of Sound." With the help of Mr. Cotterell, his assistant, he reproduced some of the experiments with sensitive flames with which he has made scientific audiences so familiar.

Dr. Stone spoke on the subject of "Just Intonation and the Limits of Audible Sound." Mr. R. H. M. Bosanquet, M.A., spoke on "Instruments of Just Intonation," and explained the construction of the enharmonic harmonium contributed by him to the collection.

Mr. F. Galton, F.R.S., in his remarks "On the Limits of Audible Sound," spoke of experiments which he had been trying for some time past on the susceptibility of various animals to the highest notes, such as those of extremely small whistles. He had arrived at the conclusion that no animals were so sensitive to sounds of the character in question as cats, which, of course, were the animals produced by natural selection to prey upon those other animals which in nature produced such sounds—namely, mice.

Prof. W. G. Adams, F.R.S., spoke on the late Sir C. Wheatstone's acoustical discoveries, and Mr. W. Chappell followed with a discourse "On Ancient Musical Science."

Mr. J. Baillie Hamilton spoke on Æolian instruments. He gave a history of the attempts in Europe to combine wind and string, and coming down to the present time he spoke of his own experiments. He has found that a metallic ring of suitable elasticity well supplies the place of a string's constraint on a vibrator. Variations in the shape of the ring produce differences of tone. Thus, passing from the circle to almond-shaped rings, all qualities from the flute to the horn are created.

M. Tresca referred to the still existing monuments of the history of science. For various reasons, want of appreciation, want of care, &c., many instruments of historical interest are lost. France is relatively well off in its historical instruments, and it is well represented in this exhibition. M. Tresca then referred to the instruments in the collection France has sent over, giving a graphic sketch of their history and the history of the progress of the sciences they have helped forward. The Earl of Rosse, F.R.S., made a brief communication on the thermopiles which he is now using in connection with the telescopes belonging to the late Earl, after which Mr. De la Rue described his electric batteries of a novel construction. The Cavaliere Prof. De Eccher made a communication on the instruments sent over from Italy.

The conversazione given by the Geographical Society on Saturday evening was in all respects a successful one; more than 2,000 persons accepted the invitations sent out.

In the second meeting of the Mechanical Section on Monday, the first paper was by Prof. Kennedy, on "Reuleaux's Collection of Kinematic Models." Prof. Kennedy explained the general principles and some of the details of these educational models designed by their constructor for the illustration of the theory of machines. Mr. W. Barnaby, C.B., then read a paper on "Naval Architecture," which we hope to publish in our next number. Mr. W. Froude, F.R.S. then gave a short lecture on "Fluid Resistance," detailing many of his experiments. The other papers read were by Mr. Thomas Stevenson, on "Lighthouses," M. le Général Morin on "Ventilation," Messrs. Dent on "Time-measurers," and Mr. J. N. Douglass, C.E., on "Instruments contributed by the Trinity House."

The Chemical Section met again on Tuesday. The President, Dr. Frankland, F.R.S., read a communication from M. le Professeur Frémy, the French Chemist, on the Diminution of Scientific Research. M. Frémy has founded and carried on during the last twelve years a laboratory for the prosecution of original investigations by students who have completed their scientific studies. The experience which he has gained is such as to lead him to the conclusion that it is necessary to invoke state aid in order to restore research to that position which it should occupy. As the State chooses its officers and engineers after a severe course of study, and then ensures their regular advancement in its service, M. Frémy claims a similar boon on behalf of pure science, which renders such invaluable services to the community. He proposes that the scientific service should consist of five grades, with salaries rising from a minimum of 120*l*. to 800*l*. per annum, and that the fitness of candidates for entrance to it should be decided by a jury of men of acknowledged scientific reputation, independence, and integrity. This jury should make known in official reports the claims of the various candidates to advancement, thus securing public criticism, and removing all opportunities of intrigue or favour. Prof. Roscoe, F.R.S., then gave a lecture on Vanadium and its Compounds, exhibiting on the table the collection of these substances

contributed by himself to the Loan Collection, representing the results of his admirably conducted series of researches in connection with this particular one of those metals designated by the chemist as "rare." The President, in thanking Prof. Roscoe, remarked, in reference to the value of scientific research, that it could not be too widely known that all the greatest results to which it had conduced had been obtained primarily by devotion to purely abstract science—practical applications having unexpectedly followed upon discovery. Prof. Guthrie, F.R.S., then gave an account of his researches on "Cryohydrates and Water of Crystallisation," a subject on which he has been working for the last three years. Prof. Williamson, F.R.S., gave an address on the "Manufacture of Steel," limiting his attention chiefly to the modes devised for the obviation and repression of the escape of carbonic oxide gas from molten steel during the casting and cooling process, after leaving the Bessemer or Siemens-Martin furnace. Mr. W. C. Roberts, F.R.S., subsequently read a paper, on the "Apparatus used by the late Prof. Graham in his Researches." The principal interest attaching to these pieces of apparatus was the simplicity of the means by which the late Master of the Mint established such important discoveries as the law of the diffusion of gases, the principle of the endosmotic action of fluids, and the consequent division of chemical substances into crystalloids and colloids. Mr. W. N. Hartley read a paper on the existence of "Liquid Carbonic Acid in the Cavities of Crystals," Dr. Gladstone, F.R.S., following with a short address on the electrolysis of organic compounds with the copper zinc couple. Dr. Frankland, in closing the Chemical Conference, congratulated the audience upon the success which had attended the proceedings throughout the two meetings.

Yesterday the Section of Physics met for the third time, when the following papers were to be read:—

Prof. J. Clerk Maxwell, "On the Equilibrium of Heterogeneous Bodies;" Prof. Andrews, "On the Liquid and Gaseous States of Bodies;" M. Sarasin-Diodati, "On M. de la Rive's Experiments in Statical Electricity;" M. Lemström, "Sur l'Aurore Boréale;" Baron F. de Wrangell, "On a New Form of Voltameter;" Il Commendatore Professore Blaserna, "Sur l'état Variable des Courants Electriques;" Mr. Warren de la Rue, "On Astronomical Photography;" Mr. Ranyard, "On the Instruments lent by the Royal Astronomical Society;" Mr. Brooke, "On Magnetic Registration, and on the Corrections of the Magnetometers;" Prof. Carey Foster, "On Electrical Measurements;" Herr Prof. Dr. Rijke, "On the Historical Instruments from Leyden and Cassel;" the Rev. R. Main, "On a Telescope of Sir W. Herschel's."

The third meeting of the Mechanical Section is held to-day.

The first meeting in the Section of Biology will take place to-morrow, when the following papers will be read:—Dr. J. B. Sanderson, the President, "On Methods of Physiological Measurement and Registration;" Prof. Marey "On various Instruments for Investigating and Registering Vital Movements;" Dr. Hooker "On the Plan of the New Laboratory for Investigations relating to the Physiology of Plants at Kew;" Prof. Dyer "On various Apparatus for Investigating and Registering the Growth of Plants contributed by the Physiological Laboratory of Bremen;" Dr. P. L. Sclater "On Drawings contributed by the Zoological Society;" Dr. Brunton "On a new Myographic Apparatus;" Dr. Klein "On Recording Apparatus exhibited by the Physiological Institute of the University of Prague;" M. E. A. Schafer "On recent Improvements in Recording Apparatus."

The Science and Art Department are organising a series of popular lectures to be given on the evenings of the free days. Demonstrations of the objects in the galleries are also now given by the exhibitors or other competent persons at frequent intervals during the day.

SECTION—CHEMISTRY.

Opening Address by the President, Dr. Frankland, F.R.S.

THE Conference which I have been requested to open to-day has for its object the discussion of the merits and defects of the various forms of chemical apparatus exhibited in these buildings; and the criticism of the original investigations which are here illustrated, partly by the instruments used in them, and partly by the chemical compounds, to the discovery of which they have led.

Various objects interesting to chemists have been displayed in former international exhibitions, but it may be safely asserted that such a collection as this, which has been brought together in these buildings, has never before been seen; neither has there before been the opportunity for discussion and criticism, by men eminent in science from all parts of Europe, which is now afforded.

Such a collection of apparatus and products, gathered from all parts of Europe is useful in disclosing, to chemical investigators and others, the best sources whence to procure apparatus; it is interesting historically and as showing the improvements in chemical apparatus during the present century; and it is instructive in the comparisons it affords of the various forms of instruments used for the same purpose in different countries, and by different experimenters.

The entire novelty of such a collection as that belonging to this section has rendered the attainment of the object sought for, on the present occasion, exceedingly difficult. The workers in science have hitherto had no inducement to preserve the *instruments* with which they experimented. When an investigation was finished the apparatus employed was dismantled and converted to other uses. Still less inducement has there been to preserve the *chemical compounds* resulting from research, although their creation required, in many cases, a great expenditure of time and labour. The chief object of preparing such compounds has hitherto been, in most cases, merely to ascertain their existence, to show their molecular relations to previously known bodies, and to ascertain a few of their leading properties such as colour, specific gravity, vapour density, melting point, boiling point, and chemical composition. They have been weighed and measured and then dismissed out of existence. And thus the present collection of chemical preparations is but the merest skeleton of a complete exposition of all known chemical compounds.

It is, indeed, remarkable, that whilst *natural* chemical compounds are exhibited in almost endlessly multiplied specimens in the mineralogical collections of our national museums, the *artificial* compounds which have resulted from research, or have been the foundation of important theories and generalisations, have nowhere been honoured by admission into national collections. The neglect, not to say contempt, with which these productions of the laboratory have been treated, cannot be justified on the ground of their want of national utility. It is true that from an exclusively commercial point of view, no one of them can lay claim to the importance of coal, iron, silver, and gold. Still, many of them, such as the paraffins, the coal-tar colours, and many of the compounds of sulphur, potassium, sodium, and ammonium, have contributed, in an important degree, to the wealth and prosperity of this and other states. Had these artificial compounds remained undiscovered, how different would now have been the condition of the industries of bleaching, dyeing, calico printing, glass-making, and the manufactures connected with the production of artificial light. Many of these artificial compounds have become of the most essential importance to the physician, the artist, the telegraphist, the engineer, and the manufacturer, and it cannot be doubted that many more would soon come into active service for such purposes if they were better known.

But not alone on the ground of utility and incentive to the further useful discovery of technical applications would I plead for the establishment of national museums of chemical preparations; such collections would be of the highest interest both to the student and the investigator. They would call vividly before the mind the results of labours which can only otherwise become known by a tedious search through the transactions of learned societies. An intelligent study of a properly arranged collection of artificial chemical compounds would show the progressive triumph of mind over matter—not over masses moved by mechanical agencies—for monuments of this the engineer and the architect need only bid the inquirer, in the language of Wren's tablet, to "look around him"—but over the ultimate atoms which, in these compounds, are compelled to submit themselves to the will of man, and to form new structures, seen only, in most cases, by the discoverer himself, and the qualities and uses of which are but very imperfectly ascertained. Nine-tenths of these compounds are no better known than islands which have been seen only from the deck of a ship and whose position has been accurately marked upon a chart. But a collection of them, if properly kept up, would represent the actual condition of our knowledge of chemical facts, and, if properly arranged, would suggest to the observant student the direction of future investigation.

I know of no other incentive to research which would be more likely to call original inquirers into existence. The student wishing to commence a chemical investigation is always confronted at the outset by the difficulty of finding the boundary line between the known and the unknown, and this difficulty must obviously increase from year to year owing to the continued expansion of the circle of knowledge. It has led to a suggestion emanating from the British Association, that chemists who are intimately acquainted with particular departments of their science should suggest subjects of research for the benefit of students. Much may be said no doubt in favour of such a scheme; but it appears to me that the development of original talent in the young investigator would be more surely promoted by giving him the means of selecting for himself a subject for experimental inquiry, rather than by inducing him to follow the less invigorating plan of working out the suggestions of others. I venture, therefore, thus prominently to call attention to the non-existence, in any country, of a museum of artificial compounds, and to the great value, both economical, scientific, and educational, which such a museum would possess. I feel convinced that if such museums were established in the capitals of Europe, chemical investigators throughout the world would gladly contribute their new products to them, and thus keep them abreast of the discoveries of chemical science.

Amongst the groups of objects in the Chemical Section, not the least interesting is that which consists of *Apparatus and Contrivances employed in the Generation and Application of Heat.* The great advances which have been made in the modes of producing and applying heat for chemical purposes are strikingly conspicuous. The cumbrous furnaces of the earlier operators, constructed in fireproof vaults, have gradually been replaced by simple and elegant contrivances, which would scarcely look out of place upon a drawing-room table. The time is still fresh in the recollection of many of us, when the fusion of a silicate for quantitative analysis, or the heating to redness of oxide of copper for the combustion of an organic compound, required in each case the expenditure of much time and trouble in the lighting of a coke or charcoal furnace. Now these operations are performed in small gas furnaces with or without air blast. Conspicuous amongst these inventions are the gas-burners of Bunsen and Hofmann, the oxy-coal gas furnaces of Deville, the blast gas furnaces of Griffin, and the hot blast gas furnaces of Fletcher. Of these fundamental inventions many ingenious modifications for special purposes have been devised, amongst which I may mention the valuable contrivances of Finkener, Mitscherlich, Wallace and Muncke. The blast gas-burners of Hofmann and Bunsen, the blast gas-furnaces of Deville, Griffin, and Bunsen, and the furnaces for organic analysis by Hofmann, Bunsen, Finkener, Mitscherlich, and Muncke, are amongst the exhibits illustrating the application of heat in chemical operations.

These burners and furnaces command a range of temperature from the gentlest ignition up to the most intense heat procurable by chemical means; but the temperature produced by such combinations as those of oxygen and hydrogen, or oxygen and carbon, enormously high though it be, now no longer suffices, and recourse must be had to the still more intense heat of the electric discharge. The electric current and the stream of sparks are now not unfrequently called into requisition by the chemist, and from this point of view the electric lamp and the apparatus of Hofmann and others for the decomposition of gases by the spark-stream must be classed with chemical furnaces.

To apparatus for the application of heat belong the various forms of water, steam, and air baths, or drying closets. Convenient contrivances of this class invented by Bunsen, Mitscherlich, Habermann, and Muncke, are exhibited by Messrs. Warmbrunn, Quilitz and Co, Mr. Johann Lentz, and Mr. Julius Schober all of Berlin, and by Mr. C. Desaga of Heidelberg.

In the application of gas to chemical purposes, regulators of pressure and temperature are often of the utmost importance, in order that operations requiring the prolonged and regular action of heat may not require the constant attention of the operator. The ingenious and effective contrivances of Bunsen and Kramer, for this purpose are exhibited.

Closely connected again with appliances for raising temperature are those intended for its reduction—the refrigerators or condensers.—The Liebig's condenser is still the refrigerator almost exclusively used, but few pieces of apparatus have been so much modified and refined, as will be seen on comparing the original design with the present construction—the final light and convenient form having been given to it by my late friend Mr. B. F. Duppa. Most manufacturers of chemical apparatus exhibit various forms of this condenser.

Sprengel Pumps.—Of the comparatively recent appliances for facilitating chemical work, few can lay claim to higher merit than the invention of Dr. Hermann Sprengel, in the year 1865, for the production of vacua by the fall of liquids in tubes; and yet this invention remained for many years dormant, until the late Master of the Mint applied the mercurial pump to the extraction and collection of occluded gases, and Bunsen the water-pump to hastening the filtration of liquids. Without the mercurial pump the elements of the organic matter in potable waters could not be determined, and the highly interesting results which this pump has quite recently achieved in the hands of Mr. Crookes, come home to every one who has seen the various forms of the radiometer.

Bunsen's application of the water-pump to filtration has done much to shorten one of the most tedious and troublesome operations of gravimetrical analysis.

Dr. Sprengel's invention has, moreover, nearly abolished the use of the air-pump in chemical laboratories, and I need not therefore, perhaps, bring under the special notice of this section the various improvements in air-pumps which are illustrated by the exhibits in the Physical Section.

Models, diagrams, apparatus and chemicals used in the teaching of chemistry, include numerous exhibits of great interest. It is to be regretted, however, that models and plans of chemical laboratories are not more numerously represented. The important improvements which have been introduced of late years, and the numerous laboratories of truly palatial proportions which have been built,

in almost every case at the cost of the State, would have rendered a complete exposition of their plans and fittings most instructive and interesting. Dr. de Loos, has, however, sent us a model of the chemical laboratory in the secondary Town School of Leyden. And we have from Mr. Waterhouse plans of the Owens College laboratories in Manchester. The latter were devised after the professor of Chemistry and the architect had visited all the great laboratories of Europe, and for compactness, economy of space, appropriateness of fittings. and ventilation, they are unsurpassed.

In illustration of the permanent fittings of laboratories we have from the Chemical Institute of the University of Strassburg a diagram showing elevation, section, and plan of a "digestorium," or iron closet, for use in dangerous operations in which explosions are liable to occur. This is a contrivance which ought never to be absent from a laboratory in which research is carried on.

Prof. Roscoe exhibits a beautiful and effective series of diagrams and models illustrating the processes carried on in alkali works, and Mr. Henry Deacon a sectional model of his ingenious apparatus for exposing porous materials and currents of gases to mutual action.

Dr. de Loos, of Leyden, has sent drawings of gas works used for teaching technical chemistry in secondary schools.

We are indebted to Mr. Spence, of Manchester, for a series of specimens illustrating his process for the manufacture of ammonia-alum. To Messrs. Roberts, Dale and Co. for specimens illustrating the manufacture of oxalic acid. To Messrs. Calvert and Co. for similar illustrations of the manufacture of carbolic, cressylic and picric acids.

Messrs. Hargreaves and Robinson exhibit plans and specimens in connection with their new process of manufacturing sulphate of soda directly from sulphurous acid, steam, air, and salt; whereby the intermediate production of sulphuric acid is avoided. A chemical factory is generally conspicuous in the landscape by a series of huge and ugly leaden vitriol-chambers. Should the new process prove as successful as the inventors anticipate, these leaden chambers will almost entirely disappear, and the aspect of chemical factories will undergo a more profound modification than any which has occurred during the last half century.

The splendid platinum apparatus of Messrs. Johnson and Matthey for the concentration of sulphuric acid, will also contribute much to compactness in chemical works, by the abolition of cumbrous leaden pans and long ranges of glass retorts.

Not only is the sense of sight thus likely to be relieved, but that of smell, which, in the case of chemical works, is perhaps of even more importance, is also gradually being subjected to less offence by the adoption of Mond's process for the recovery of sulphur from soda-waste. The vast mounds of this material which surround alkali works, not only pollute the air with sulphuretted hydrogen; but also the neighbouring streams, with an offensive drainage which is very destructive to fish life. Herr Mond has succeeded in profitably extracting the sulphur—the offending constituent of the waste—and Messrs. John Hutchinson & Co. of Widness, exhibit specimens illustrating this important process.

Dr. Van Rijn, of Venlo, Netherlands, exhibits fine crystals of potash and chrome alums. One of the Octohedrons of potash alum weighs no less than 11 lbs.

Messrs. W. J. Norris and Brother of Calder Chemical Works have sent specimens useful in teaching the technology of lichen colours, sulphate of alumina, and bichromate of potash.

Messrs. Brooke, Simpson, and Spiller contribute a fine series of specimens illustrating the technology of coal-tar colours.

Lastly, several magnificent series of specimens have been sent over by members of the German Chemical Society.

They comprise, firstly, some items of much historical interest. Thus, we have from Prof. Wöhler the first specimens of boron and aluminium ever prepared. And, from the same chemist, another historical specimen which, it is no exaggeration to say, is the most interesting now in existence, for, after the discovery of oxygen, it marks the greatest epoch in chemical science. I allude to this specimen of the first organic compound prepared synthetically from its elements by Wöhler, without the aid of vitality. If the work of the army of chemists who have successfully attacked the problems of organic chemistry during the last quarter of a century were to be described in one word, that word would be SYNTHESIS. In this specimen of urea we have then the germ of that vast amount of synthetical work which has done so much to dispel the superstition of vital force and to win for chemistry the position of an exact science. In the absence of a specimen of the first oxygen from Priestley's laboratory in 1774, it seems to me that this specimen of the first synthesised urea made in 1828 is, historically, the most interesting chemical the world has to show.

Secondly, we have a beautiful collection of all the compounds discovered by Liebig, but I need not dwell upon them, as they have been so recently described by their exhibitor, Prof. Hofmann, in his Faraday lecture delivered to the Fellows of the English Chemical Society.

And thirdly, there are several interesting series of specimens illustrating the researches of Biedermann, Weltzien, Michaelis, Hübner, Hofmann, Lieberman, Oppenheim, Pinner, Wichelhaus, Tiemann, and others.

We come now to a review of that sub-division of the Chemical Section which illustrates original research, viz., chemical compounds discovered in certain specific investigations, and apparatus used in the prosecution of research. Whilst the sub-division which I have been describing illustrates for the most part the training of the young chemist in habits of observation and in the use of apparatus and processes, the one we are now considering aims at representing, so far as it can be objectively represented, the highest outcome of this training—the additions to our knowledge acquired through the accurate methods of observation and experiment which it is the function of the chemical instructor to teach. I have already remarked on the interest and importance of exhibits of this class, and it is to be regretted that out of so many chemical investigators so few have exhibited. It is characteristic of the direction long taken by chemical research, that of about 25 exhibitors only two have contributed mineral as distinguished from organic products.

Prof. Roscoe exhibits sixty-five compounds of vanadium discovered and investigated by himself. This classical research stands out as a model of thoroughness, and not only clearly discloses the habits of a comparatively rare metal, but brings to light some new and interesting facts in connection with the theory of atomicity. As Prof. Roscoe has consented to deliver an address on these compounds, we shall have an opportunity of discussing the peculiarities and anomalies which have presented themselves in the course of this investigation.

The water of crystallisation of salts has been the subject of some controversy amongst chemists of late. It is generally considered to be present in atomic proportions, however complex these may sometimes be, and most chemists are inclined to regard the bond of union between this water and the salt proper in the light of a *molecular*, as distinguished from an *atomic*, attraction. Mr. Walcott Gibbs, however, has recently endeavoured to show that the union is strictly atomic, and subject to the ordinary laws of atomicity. The subject has attracted the attention of Prof. Guthrie, who has attacked it from a new side, and obtained results which throw much light on this question. He has promised to give us an address on the subject at the next Chemical Conference. Prof. Guthrie also exhibits—

Nitroxide of Amylene.—Discovered by the exhibitor. Of historical interest as being the first instance in which nitroxyl NO_2 was shown to behave as a halogen in uniting directly with an olefine to form a body homologous with "Dutch liquid." The composition of the body is $C_5H_{10}(NO_2)_2$.

Sulphide of Œnanthyl.—Discovered by the exhibitor, and of historical interest as being the first instance in which a term of a higher alcohol series was made from terms of lower alcohols. It is formed by the action of zinc ethyl on sulpho-chloride of amylene.

And Nitrite of Amyl.—Discovered by M. Balard. Its therapeutic action was discovered, and its introduction into the pharmacopœia recommended, by the exhibitor; and it is now coming into use in tetanic and other nervous affections.

A series of twenty-three specimens of hydrocarbons derived from Pennsylvanian petroleum is exhibited by Prof. Schorlemmer. They form a striking record of the skill with which a most laborious and difficult investigation has been conducted.

Very interesting and important are the ethyl compounds derived from the isolated radical methyl exhibited by Mr. W. H. Darling. The results of some experiments made by myself seemed to indicate that the products of the action of chlorine upon methyl were not ethyl compounds; but the experiments of Schorlemmer and Darling, conducted with much larger quantities of material, show that my conclusion was erroneous. Mr. Darling exhibits ethylic chloride, ethylic alcohol, ethylidenic chloride, and sodic acetate, all made from electrolytic methyl.

Mr. Perkin has sent a large collection of specimens illustrating his researches on mauveine, artificial alizarin, artificial coumarin, glyoxylic acid, and other subjects. His investigation of glyoxylic acid seems to have at last put an end to the controversy as to the possibility of two semimolecules of hydroxyl being united with one and the same atom of carbon. I will not, however, anticipate Mr. Perkin, who will, I trust, personally give us an account of his researches.

Amongst the other exhibits in this department are numerous and important contributions from the laboratories of St. Petersburg, Louvain, and Edinburgh. For several years past chemical research has been actively carried on in Russia.

The apparatus of research exhibited in the Chemical Section has suffered much from the depredations of the physicists, for although chemistry is essentially founded upon measurements of weight and volume, the instruments used for such determinations have been swept almost *en masse* into the section of measurement; nevertheless, the chemical section contains several objects of unusual interest. The apparatus with which chemists both ancient and modern prosecuted their researches was generally of a simple description, and often dismantled as soon as the necessary operations were completed; consequently it was far less likely to be preserved than the more expensive and elaborate contrivances of the physicist. Here, however, is Black's balance, presented to the Science and Art Museum of Edinburgh by the Right Hon. Lyon Playfair. Upon this balance Dr. Black ascertained in 1755 the loss of weight suffered by carbonate of magnesia and limestone when exposed to heat. Hales previously used a balance for this purpose, but the instrument before us was certainly one of the first employed for quantitative chemistry. The balances used by Cavendish, Davy, Young, and Dalton are here, and each one of them has its own historical interest for the chemist. The balance of Cavendish is probably the instrument with which in 1783 or 1784 he first ascertained that a globe filled with a mixture of oxygen and hydrogen gases underwent no alteration in weight when the mixture was exploded.

From gravimetric instruments we are naturally led to volumetric apparatus used in quantitative chemistry, and I will now, in conclusion, briefly direct the attention of the conference to apparatus used in the analysis of gases, in the hope that a discussion of the merits and defects of the numerous instruments now before me may have the effect of directing a larger share of attention to eudiometric chemistry than has hitherto been accorded to it. This branch of chemical analysis originated in the attempts of Fontana, Landriani, Scheele, Priestley, Cavendish, Gay-Lussac, Dalton, and others, to determine the volume of oxygen in samples of atmospheric air taken from various localities. In these primitive instruments air was exposed to the action of some substance either solid, liquid, or gaseous, which combined with the oxygen and left the nitrogen unacted upon. The chief substances used were phosphorus, potassic sulphide, nitric oxide, a solution of nitric oxide in ferrous sulphate, and a mixture of sulphur and iron filings. Many of these instruments were of simple or even rude construction, and little calculated to inspire confidence in the results. Nevertheless, the accuracy of a determination often depends much more upon the skill of the operator than upon the construction of the instrument used; and thus Cavendish, with nitric oxide as his reagent and water as the confining liquid, made many hundred analyses of air, collected in various localities, in 1781, and found the percentage of oxygen to be invariably 20.83, a number nearly identical with those obtained by Bunsen and Regnault with much more perfect means. But the average chemist of that day obtained the most discordant results with the same apparatus and materials, and would doubtless also do so at the present day. By improved apparatus and methods the work of the average chemist is made to equal, or nearly so, that of the most skilful.

Volta introduced a new reagent, hydrogen, for the determination of oxygen, and he was the first to employ the electric spark in eudiometry. The use of mercury instead of water for confining the gases eliminated the source of fallacy caused by transfusion through the latter liquid, and lastly Bunsen, in the year 1857, brought Volta's eudiometer to its highest degree of perfection.

The President then proceeded to describe and criticise the various forms of apparatus for the analysis of gaseous mixtures, and concluded as follows:—

Such are the modern developments of the eudiometer now at the disposal of chemists. For rapidity of working and delicacy of measurement they leave nothing to be desired; indeed, as regards delicacy it may be doubted whether amongst all the instruments for measurement in this exhibition, there is one which can, like some of these eudiometers, give a distinct value in weight or volume to the one fourteen millionth part of a gramme of matter. Their drawback is their fragility, and any modifications to diminish this would doubtless be welcomed by chemists, since, chiefly for these reasons, eudiometry is still very rarely practised in chemical laboratories.

THE PRESS ON THE LOAN COLLECTION

IN continuation of our article in last week's number we proceed to give a few more selections from the principal organs of public opinion, indicative of the light in which they regard the scientific collection which has been brought together at South Kensington. Last week we confined ourselves mainly to the daily press; this week we are able to cull the opinions of the principal weekly papers. Public opinion as thus expressed, it will be seen, all but unanimously approves of the collection as creditable to its organizers and to the country at large, as beneficial to the progress of science, and as calculated to have an important educative influence on the British public. We think the collection of public opinion as thus expressed will serve a good purpose. It will show to those men of science who have been more or less connected with the

organization of the Loan Collection that their efforts have met with the approval of the intelligent and unprejudiced portion of their non-scientific fellow-countrymen, that these efforts have been unexpectedly successful, and that public opinion points to a permanent successor as the natural outcome of this temporary collection.

The *Saturday Review* seldom gives way to unmeasured approval of any human effort; it is therefore extremely gratifying to find so severe a critic having nothing but praise to bestow on the collection. The following are a few extracts from last Saturday's number:—

"Mr. Spottiswoode, in his address as President of the first of the Conferences which have been arranged in connection with the Loan Collection of Scientific Apparatus at South Kensington, said that he was disposed to regard this Exhibition as marking an epoch in the history of science; and there are undoubtedly reasons why it may be expected to exercise a deep and beneficial influence on the prospects of scientific culture in this country. We have here brought together, not only a collection of remarkable instruments from all parts of the civilized world, and representing almost every school and period of research, but also a numerous gathering of the men who are at the present moment engaged in extending still further the range of discovery, and the practical application of its results. It has often been a reproach against this country on the part of foreigners that it is indifferent to science except in the forms in which it can be turned to immediate commercial profit; and this criticism, though unjust to the heroic self-sacrifice which has characterised many of our leading scientific pioneers, must be admitted to be in a certain degree true as to the general attitude of the public. . . . . In this country the Executive usually hesitates to do anything unless there is a strong pressure of opinion, and it is tolerably certain that science will have little to hope for from that quarter until it has the public at its back; and it is to it, therefore, that an appeal should be made. It may be hoped that the present Exhibition will be the beginning of a movement of this kind. The fact that it is opened under the auspices of a Government department would seem to show that there is not wanting a certain sympathy on that side; but whether any large, substantial measures will ever be taken, will chiefly depend on the interest which such a presentation of science excites among the community at large. Again, an Exhibition of this kind is useful in bringing to light the actual operations of the scientific world, the problems which have been solved, and those others which are still in a nebulous condition, with just here and there a clue peeping out; and thus the interchange of ideas is promoted. . . . . At present this sort of co-operation is loose, fragmentary, and disjointed; but an Exhibition brings the scattered experimentalists into systematic communication. Thus, both in the world of science proper and outside of it, a keener interest is likely to be cultivated in regard to scientific matters, and researches will consequently be conducted with greater spirit and efficiency, and better prospects of success. . . . . To persons of scientific training, or with even a rudimentary taste for such things, it is easy to conceive what service such an Exhibition will render. They will read the Handbook, an admirable summary of the chief branches of scientific study by competent authorities, and examine the objects exhibited; and thus lay up a store of suggestive information as a supplement to or a foundation for private studies. But there will also be a large body of people who will chiefly bring away from the galleries an impression of their own stupendous ignorance in such matters. This in itself, however, will be a good thing, for it may be expected, in some cases at least, to stimulate a desire to know something, and after that to know more. Even the dullest and least imaginative minds can hardly fail to be touched by the sight of the instruments by which the old masters achieved their triumphs, or of their earliest works. . . . . On the other hand, this Exhibition displays in a striking manner the wealth and luxury of scientific apparatus at the present day."

After giving examples of the intimate connection which subsists between the progress of science and the improvement of its mechanism, the article concludes thus:—

"It is impossible here to go through such an Exhibition in detail, and we can only say that it reflects much credit on those with whom it has originated, and that it is to be hoped that it may not be a mere passing show, but may develop into some permanent organization."

The *Academy* of last Saturday has "a first or introductory notice" of some length on the collection.

"The Special Loan Collection of Scientific Apparatus," the *Academy* says, "which was honoured by a private visit from her Majesty on Saturday last, and thrown open to the public on Monday, is one of very great interest and value. The Lord President of the Council may well be congratulated on the success of the undertaking, and we must all feel grateful to him for having given us an exhibition in which, for once, purely commercial interests have been made to give way to the 'higher aim of disseminating as widely as possible a knowledge of the different methods of science.' The Exhibition is in many respects the most instructive and remarkable that has been held at South Kensington, and though it may not have any great effect on the advancement of science or on the industrial progress of this country, it cannot fail to awaken a very general interest in those methods of abstract scientific research of which the public know so little; and it will afford an opportunity, which may never occur again, of examining at leisure under the same roof the rude, simple instruments used by the pioneers of science, and the complex, delicate apparatus with which investigators of the present day have made their discoveries. We trust, too, that the Exhibition may give an impulse to the cause of scientific education in this country, and that it may lead to a better appreciation of the reasons which have led men of science to advocate Government endowment of scientific research, and the establishment of Physical Observatories, at home and abroad, which may have the same beneficial influence on the progress of other sciences that Astronomical Observatories have had on the progress of astronomy. May we hope, too, that the Exhibition will lead to the creation of a museum for the illustration of physical, chemical, and mechanical sciences somewhat of the nature of the 'Conservatoire des Arts et Métiers,' in Paris? The formation of such a museum was one of the recommendations of the Commission on Scientific Instruction, and we believe it would go far, by affording adequate opportunities for study, to render the sciences alluded to as popular as those of botany, geology, and zoology."

Last week we quoted the opinion of *Iron*; the same paper has another interesting article this week, on "Science at South Kensington," in which it says that the success of the Exhibition affords an additional instance of the certain, if tardy, fructification of a valuable idea. "Years ago the conception of a great focus of science somewhere in the metropolis was formed in at least one great mind." The article then refers to the original intention of making the Albert Hall an institutional memorial, its employment as a place of scientific meetings and conferences having been strongly advocated. With its present uses, "the building has lost all its signification, as its position at South Kensington has lost all its appropriateness. We therefore cordially welcome the realisation of the spiritual part of the original plan, although it has been brought about by indirect means." The article then goes on to refer to the successful development of loan collections during the last few years, and the superior educational value possessed by special collections over large international exhibitions. As carried out at South Kensington, this value is largely

owing to classification, "a point kept distinctly in view in arranging the Exhibition of Scientific Apparatus." The article then proceeds: -

"The problem of classification has been triumphantly solved. . . . . Success is absolute and complete.

"The institution of conferences during the Exhibition can hardly be regarded as other than a most valuable innovation, and precisely what was wanted--not to popularise the Exhibition, but to give it that life and movement without which the best institutions are apt to become stagnant, and be passed heedlessly by in an age of hurry and bustle. . . . There is no slackness at South Kensington, and conferences form an interesting and important part of the programme of the Scientific Exhibition which it is rumoured will probably prove the nucleus of a Scientific Museum analogous to the Conservatoire des Arts et Métiers at Paris. It would certainly be shortsighted policy to allow the splendid collection of objects now brought together for the first time in the world's history to be redistributed--scattered all over Europe, in odds and ends which teach little or nothing apart, but are of inestimable value when together. The want of a permanent national institution devoted to science can now be supplied in the least costly and most efficacious manner, that is to say, the vital part composed of the scientists and their instruments. As for the showy part -the outward and visible sign the Central Hall of Science, it will come in time. If Albert Hall, after having failed as a music-hall, fails also as a circus and as a skating-rink, the country may one day be able to buy it up cheap, and convert it to a legitimate use."

The *British Journal of Photography* says:—

"There is now open in the Exhibition Buildings, South Kensington, London, a large, varied, and most valuable collection of scientific apparatus and appliances. Its intrinsic value is great, its historical value much greater, but in its educational importance is to be found the chief value of this unique collection."

The *Gardeners' Chronicle* speaks thus:--

"The splendid collections of Scientific Apparatus now on view at South Kensington may not have any great interest or attraction for the general public, for whose taste the display is too technical and unintelligible. To the more thoughtful visitor, and especially to the student, the collection is rich in interest and suggestiveness. . . . The whole thing has been organised and got together so quietly that even among scientific men little or nothing was known about the proceedings till the last moment, and the extent and value of the collections has come upon them as a surprise."

Public opinion thus far, it will be seen, has nothing but admiration for the Loan Collection. The *Athenæum* is on the other side. We give its article without note or comment, as the collection can hold its own.

"The galleries containing the Loan Collection of Scientific Instruments are at length open to the public. Apparently no expenditure has been considered too great by those who have been engaged in bringing together in the course of a few weeks from every part of Europe all the relics of science that could be begged or borrowed from public institutions or private collections. Gentlemen have been sent on special missions from South Kensington, and their movements have been duly chronicled in Reuter's telegrams amongst the most important news from Italy and Germany. Where these gentlemen could not find time to go, ambassadors and their attachés have been pressed into the service of collecting. Special railway trains have, we are informed by our contemporary, NATURE, been built for the transit of instruments, and the result is a collection of brass, glass, and old iron relics, which has driven the daily press wild with enthusiasm.

"According to the ordinary law of chances, a certain proportion of these instruments will be returned to the places whence they came all the worse for their journey across Europe, and we feel inclined to inquire whether it is certain that the worker in science will be the wiser for having seen them. The old and celebrated instruments have been repeatedly described and figured, and the new instruments, if useful, a man engaged in scientific research knows better than he knows the way to South Kensington. As to the curiosity-loving public, it will surely not be pretended that it is worth while to form such a collection for its amusement, but if it be the duty of government to gratify the craving of idlers, let us by all means at once appoint a Barnum to be Minister of Science; he will know how to make such exhibitions as this, and the School of Art needlework, a commercial success. But, no doubt, real instruction is intended, and if so, let us stop and ask whether the present is the best and cheapest plan of obtaining our object. The 'general public,' so far as can be judged from the experience of the first few days, regards the whole affair with indifference.

"In order to afford the means for studying the history of a science there is needed a continuous series of objects that will illustrate the development of thought step by step; such a collection cannot be brought together in a few weeks. It needs the patient labour and study of a lifetime devoted to it; but in this exhibition, as in collections made by the *nouveaux riches*, the extremely old and extremely curious have been brought side by side with the complicated results of modern workmanship; and we find none of the connecting links, to gather which requires a man well versed in the history of his subject, and the labour of a lifetime. . . . In fact, the collection required the control of a hand familiar with the history of astronomy. Objects that would have illustrated the development of the telescope during the seventeenth and eighteenth centuries should have been sought after more diligently than relics connected with great and popular names with which every one is familiar.

"The general 'Handbook to the Exhibition,' which has been published, is a remarkably good shilling's worth of information, but, as might be expected, it contains treatises of very different merit. After some general considerations on instruments by Prof. Clerk Maxwell, which will possibly be above the heads of most of his readers, follow some interesting though rather general disquisitions on various subjects, which have evidently in most cases been written without reference to the instruments brought together. The names of Prof. Clerk Maxwell, Prof. Smith, Prof. Clifford, Mr. Spottiswoode, Prof. Tait, and others, will be a sufficient guarantee of the trustworthiness of the information given. The article on Astronomy is not equal to the others, and considering the opportunity that the author had of illustrating the history of his subject, it is particularly poor and superficial. The 'Handbook' in general will well repay more than a casual perusal."

We did not state that "special railway trains" had been built for the purpose referred to above.

THE *Challenger* is expected home daily, and arrangements are being made for the ship being welcomed on its arrival at Sheerness by the Royal Society and the foreign men of science now in this country.

THE visitation of the Royal Observatory is fixed for Saturday, June 3.

THE Anniversary Meeting of the Royal Geographical Society was held on Monday. The total number of ordinary Fellows on the list at the end of April was 3,125. Sir H. Rawlinson, the President, presented the Founder's Medal to Lieut. Cameron, and the Patron's Medal to Mr. Lowther for Mr. J. Forrest, the Australian explorer. The annual geographical medals offered by the Society to the chief public schools were presented to the

following successful competitors, viz. :—In physical geography, gold medal, John Wilkie, Liverpool College; bronze medal, Walter New, Dulwich College; and in political geography, gold medal, Thomas Knox, Haileybury College; bronze medal, W. M. H. Milner, Marlborough College. The President then delivered the annual address on the progress of geography, in the course of which he announced that he had received a communication from the Chancellor of the Exchequer that morning, that, considering the very great importance of the discoveries of Lieut. Cameron, her Majesty's Government had decided to share the expenses of the Expedition. A sum of 3,000*l.* will be handed over to the Royal Geographical Society on that account.

THERE is at present being erected in the Paris Observatory Gardens a house for the Bishofsheim transit instrument, which has been admirably constructed by Eichens. The house possesses many peculiarities, and was designed by M. Leverrier for the better insuring of equality of temperature. The roof can be removed on horizontal rails, and the walls are so perforated that there is a continual circulation of air in all parts. The frame of the house may be said to be pneumatic, as it has been constructed on a system analogous to that of the bones of birds. It is sure to work admirably.

THE Woodwardian Museum at Cambridge has this week received an important accession in the rich collection of fossils presented by the veteran geologist, Mr. J. W. Walton, of Bath. In many respects, this collection, little known and studied by palæontologists, corresponds for the Southern Jurassic rocks to that of Mr. Leckenby, already at Cambridge, for the contemporaneous Yorkshire beds; but in addition, the general series of fossils is very interesting. Mr. Walton's Cambrian fossils constitute one of the finest existing assemblages from these rocks. Mr. Keeping, who has superintended the transfer to Cambridge, estimates the number of specimens at a hundred thousand; the entire weight is nearly two tons and a half. Thus the opportunities for palæontological investigation, at Cambridge already very great, are largely increased.

BIOLOGICAL students at Cambridge, and many others, will regret the approaching departure of Dr. Martin, Fellow and Lecturer of Christ's College, who has accepted the Professorship of Natural History in the University of Baltimore. Dr. Martin has attained the highest honours both at London and at Cambridge in a wide range of subjects. He has been largely associated with biological instruction at University College, London, and at South Kensington, while his connection with Dr. Michael Foster in the development of biology at Cambridge has been of great value. His co-operation with Prof. Huxley in the production of the very successful "Course of Practical Instruction in Elementary Biology," is well known. Some compensation for Dr. Martin's loss at Cambridge may be found in the thought that biology in the United States will gain by the presence of a man so well versed in European methods, and especially in the systems of instruction worked out by Prof. Huxley, Dr. Foster, and others in England.

FROM the daily Weather Maps issued from Hamburg by the German Seewarte, which embrace the whole of Europe, except the extreme south and the extreme north, we observe a very remarkable distribution of the atmospheric pressure for some weeks back. Barometers have been constantly low in southern or eastern regions, and high in the west and north, resulting in a persistent prevalence of northerly and easterly winds over nearly the whole of the continent. The maps suggest that this state of things has probably extended far to north-westwards, and in accordance with this supposition letters from Iceland inform us that the Greenland and Spitzbergen ice descended, in the beginning of this month, on the north coast of that island to a very serious extent, filling the sea as far as the eye could reach. In this connection, the observations made by the Arctic Expedition will have a peculiar meteorological value.

M. HOUZEAU has been appointed Director of the Royal Observatory of Brussels.

THE results of the daily photographs taken by M. Janssen at his observatory at Montmartre are rather interesting. In February a number of spots were visible and photographed; this number was gradually reduced to two groups, each consisting of two large spots, which were visible on March 13. By March 18 only two spots were visible, the two others having disappeared owing to the rotation of the sun. The two last disappeared by March 25, and from that time up to May 20 not a single spot was recorded, the solar disc appearing quite homogeneous. Such a phenomenon is very rare, indeed, although we are nearing the minimum. The photographs taken by Janssen are 20 centimetres diameter on a collodion film, when the sky is clear. Under unfavourable circumstances, the diameter is reduced to 10 centimetres. M. Janssen takes his photographs irrespective of the presence of clouds. He uses his celebrated *revolver*, and operates before ten o'clock in the morning. He is using not only the instruments taken to Japan for the last Transit, but the very canvas, with the canvas rotating domes. No doubt the Minister for Public Instruction will give him very shortly the means of building a permanent observatory, which is to be styled the Paris Physical Observatory. M. Janssen is also asking the means to build a large refractor worth 200,000 francs.

THE *Nord-Deutsche Allgemeine Zeitung* states that the German Imperial Government proposes to establish a Meteorological Institution, the meteorological department being up to the present moment merely a part of the statistical office.

AT a recent meeting of the Birmingham Natural History Society, the meteorite which recently fell in Shropshire, and to which we referred at the time, was exhibited and described. The following resolution was very properly passed unanimously by the Society:—"That in the opinion of this meeting the meteorite exhibited should become the property of the nation, in order that it may be submitted to the fullest scientific investigation at the hands of the most competent authorities." The above resolution was passed in consequence of an application made to the finder of the meteorite on behalf of the Duke of Cleveland.

L'Exploration of May 18 contains an account of the principal indigenous tribes of Eastern Siberia, taken from a recently-published work of M. Octave Sachot, "La Sibérie Orientale et l'Amérique Russe. Le Pôle Nord et ses Habitants." The information contained in the work seems to be mainly derived from the voluminous notes of an American engineer who sojourned for three years in the region in question.

M. TH. MOUREAU, an assistant in the Meteorological Service at the Paris Observatory, has been promoted, at the request of M. Leverrier, to the position of "Physicien adjoint," by M. Waddington. Although a young man, he has rendered important service in the provisional department of practical meteorology.

MR. A. SUTHERLAND, writing from Invergordon, Ross-shire, May 13, states:—For the last fortnight almost daily iridescent halos, of more or less completeness, have been noticed round the sun, towards evening. Those on the 5th and 10th were very brilliant. The former consisted of a rainbow-coloured circle reaching almost from the zenith to the horizon, and continued for two hours. The halo visible on the 10th was an almost complete example of the phenomenon, consisting of, when observed at 6.30 P.M., two iridescent circles (22° and 46°) with tangent arc and mock-suns. The inner circle of 22° showed more especially the red rays on its concavity, except at the parhelia, where it was

brightly iridescent. A pale light stretched through the sun from one parhelion to the other, and somewhat beyond these. The tangent arc of this inner circle was also very bright and well defined. The larger circle was complete except where the hills on the horizon hid a small portion. The tangent arc was not observed above it, the sky being clear where it would be projected. The day had been very warm, but towards evening a cold north-easterly wind blew, and the part of the sky where the sun was had become somewhat misty before the appearance of the halo. Lately the north-easter has plentifully furnished the conditions for the "icy cloud" which makes these appearances possible.

THE *Pandora* is expected to leave Portsmouth to-day for her Arctic cruise.

PROF. O. C. MARSH, in a short paper on some characters of the genus *Coryphodon*, Owen, figures the skull of the American *Bathmodon* of Cope, which he shows to be undistinguishable from *Coryphodon*. This oldest known representative of the ungulate animals, found in the London clay of England, the *Argile plastique* of France, and the lower Eocene of Utah, Wyoming, and New Mexico, possessed, besides the full complement of teeth (44), five digits on each limb, and a third trochanter to the femur. The cerebellum was peculiarly small, and the cerebrum very large in proportion.

THE Prefect of the Seine has appointed a Commission composed of M. Alphaud, the chief engineer of the city, two other engineers, and the head of the Public Gardens to study some of the public works of London, such as the Metropolitan Railway, the gardening of the public parks, the sewage and water system, &c. The French Minister of Public Works will be represented in that Commission by M. de Villiers, chief engineer of Ponts-et-Chaussées.

A COMMISSION has been appointed by the Prefect of the Seine to construct a number of primary clocks in Paris for the purpose of distributing the time by means of electricity. Up to the present time clockmakers have been obliged to make personal application at the Observatory to compare their chronometer with the standard chronometer, which is regulated by the observation of the celestial bodies once a week.

THE numbers of the *American Naturalist* for February and March contain, among other papers, one by Mr. A. Agassiz on Haeckel's Gastræal theory, one by Mr. H. D. Minot on the Summer Birds of the White Mountain Region, one by Dr. H. A. Hagan on the Development of Museums, one by Dr. J. G. Cooper on Californian Garden-Birds. There is also a reply by Dr. E. Coues to Mr. J. A. Allen's "Availability of certain Bartranian names in Ornithology." Dr. H. A. Hagan describes the Goshawk from among the Game Falcons of New England. Mr. Scudder describes the nature of the chirp of the Mole Cricket. Mr. Abbot writes on the indications of the antiquity of the Indians of North America, derived from a study of their relics.

WE observe from the recent numbers of the *Bulletin International* of the Paris Observatory that the annual reports for 1875 are being received, and in considerable numbers, from the presidents of the departmental meteorological commissions, as was earnestly requested some time ago by M. Leverrier, in order that the *Atlas Météorologique* for 1875, may appear with as little delay as possible. In proof of the activity and earnestness manifested by many of the departments, it may be stated that from the department of Bouches du Rhône tables of observations from thirty-one stations have been received—a number far from being too large if the meteorology of this part of France is to be prosecuted at all successfully with a view to its practical applications.

IN the same journal, of May 5, appears an interesting account by M. Piche, Secretary of the Meteorological Commission of the Basses-Pyrénées, of a sirocco which occurred in that department on September 1, 1874. On that occasion the shade-temperature near St. Jean-de-Luz rose from 78°·8 at 8 A.M. successively to 89°·6, 93°·2, 96°·8, and 101°·3. At Biarritz the temperature also rose to 101°·3, and the difference between the dry and wet bulbs at 4 P.M. amounted to 20°·7. The observations made at the nine meteorological stations of the department at the time, are given, but the number of stations is evidently too few to furnish the materials required for the investigation of this remarkable sirocco. An interesting point, however, is this—the almost unprecedented heat and drought at Biarritz occurred during a rapid and short-continued fall of the barometer, the heat and drought being at the maximum a little before the barometer fell to the lowest point.

WE have received *Osservazioni Meteorologiche*, anno v., No. 14, published under the direction of the well-known meteorologists, P. F. Denza and P. Maggi, by the Alpine Club of Italy. This number gives a full and detailed statement of the meteorological means and extremes during the second decade of April, 1876, at fifty-one stations situated on or in the immediate neighbourhood of the Alps and Apennines, the stations being at heights varying from 87 to 8,360 feet above the sea. The publication worthily occupies a well-marked sphere of operation, and its appearance thrice a month offers great facilities for the study of the meteorological changes in the course of the year along the slopes of these mountain ranges. It would much enhance the usefulness of the results if the barometric and thermometric means for 9 A.M. and 3 P.M. were given separately.

IN the *Fenland and Eastern Counties Meteorological Circular and Weather Report* for May there appear, in addition to the usual matter, the first of a series of papers by the Rev. W. Clement Ley, on wind laws, and a second notice of Mr. Buchan and Dr. Mitchell's paper on the weather and mortality of London, in which the author, Dr. J. M. Wilson, makes some interesting comparisons as regards a few of the most important diseases between the results obtained for London and those for Wisbeach.

AT a recent meeting of the Manchester Field Naturalists' and Archæologists' Society, Mr. Faraday gave an account of a plantation of the *Eucalyptus globulus*, at Hyères, in the department of Var, in the south of France. Three years ago M. Cortambert planted 2,000 seedlings a few inches high over one hectare of land. The trees are now about thirty feet high, the stems having a circumference of about fourteen inches at three feet from the ground. It has of course been necessary to thin the plantation. A branch in flower was recently laid on the table at a meeting of the French Central Society of Horticulture. The wood of the Eucalyptus is extensively used in Algeria for carriage building. Plantations of this tree are becoming numerous in the south of France.

THE full complement of sea-water required for the filling and successful maintenance of the marine tanks at the Westminster Aquarium—over 500,000 gallons—has been delivered, and the importation of marine specimens will be rapidly proceeded with. Many interesting examples of ocean life are already on view in the smaller tanks stationed in the Eastern Annexe.

THE additions to the Zoological Society's Gardens during the last week include a White-thighed Colobus (*Colobus bicolor*), from W. Africa, presented by Mr. A. J. Keason; a White-backed Trumpeter (*Psophia leucoptera*), from S. America, presented by Mr. H. S. Marks, A.R.A.; two Javan Fish Owls (*Ketupa javanica*), received in exchange; a Thar Goat (*Capra jemlaica*) born in the Gardens, the mother belonging to the collection of H.R.H. the Prince of Wales; a Falkland Island Thrush (*Turdus falklandicus*) from Chili, deposited.

SCIENTIFIC SERIALS.

American Journal of Science and Arts, April 1876.—Prof. Wright, of Yale College, examined last year the gases obtained at moderate temperature from a stony meteorite of Iowa County; their chief constituent was carbon dioxide. He has further examined several other meteorites of both classes (stony and iron, five of each), and the results, here communicated, confirm his former conclusions. Not only do the stony meteorites give off much more gas at low temperatures than the iron, but the composition is quite distinct. In no case of the latter was the amount of carbon dioxide more than 20 per cent. at 500°, nor than 15 per cent. from the whole quantity evolved, and the volume of carbonic oxide was, in every case but one, considerably larger. In the chondrites, on the other hand, the percentage of carbonic oxide is very small, while the carbon dioxide is (with one slight exception) more than half of the total quantity of gas obtained up to red heat. At a temperature of about 350° it constitutes from 80 to 90 per cent. of the gaseous products, in all cases, while at the heat of 100° it forms somewhat more than 95 per cent. in the two cases examined in this respect. The hydrogen, on the other hand, progressively increases in quantity with rise in the temperature of evolution, and in the last portions given off at a red heat is generally the most important constituent. The evolution of those large volumes of carbon dioxide may be taken as characteristic of the stony meteorites, and its relation to the theory of comets and their trains is certainly of great significance. Prof. Norton gives a succinct account of researches made with a view to determine the laws of the set of materials resulting from a transverse strain under various circumstances. He studied (1) sets from momentary strains, (2) sets from prolonged strains, and (3) duration of set, and variation of set with interval of time elapsed after the withdrawal of the stress. Some of the results are rather at variance, apparently, with the conception of the ultimate molecule, as made up of a limited number of precisely similar atoms endued with unvarying forces of attraction at certain distances and repulsion at other distances —According to Prof. Le Conte, mountain ranges are formed wholly by a yielding of the crust along certain lines of horizontal pressure; not, however, by bending of the crust into a convex arch filled and sustained by a liquid beneath, but by a crushing or mashing together horizontally of the whole crust with the formation of close folds and a thickening or swelling upward of the squeezed mass. In an interesting paper he adduces evidence of this from the coast range of California, which is destitute of granite axes, and has been little changed by metamorphism or overlaid by igneous ejections. Prof. Newcomb criticises somewhat unfavourably the physical theories of climate maintained in Croll's recent work on Climate and Time in their Geological Relations.—Prof. Mallet studies the constitutional formulæ of urea, uric acid, and their derivatives, and in an appendix Prof. Marsh describes the principal characters of the Brontotheridæ, with aid of some excellent plates.

Mind, April.—In this number Mr. G. H. Lewes draws attention to the absence of strictly defined technical terms in psychology, and "the deplorable and inevitable ambiguity" which in consequence clouds the discussion of psychological questions. After referring to various senses in which the words sensation, sensibility, consciousness are used, he puts the question: "are all changes in the sensitive organism to be included under the term consciousness, or only some changes?" We believe some psychologists would answer: no changes in an organism ought to be called consciousness.—Prof. W. Wundt of Leipsic contributes a solid paper on "Central Innervation and Consciousness." He accepts physical automatism as flowing from the doctrine of the conservation of energy. "If this principle lays claim to a universal validity, we cannot withdraw from it those movements which we are conscious of only as psychologically caused." What he means by psychological causation is not very clear.—M. Sidgwick's "Methods of Ethics" is ably reviewed by Prof. Bain, who while speaking of the work in terms of highest praise, finds, nevertheless, that justice has scarcely been done to utilitarian ethics, and when Mr. Sidgwick, finding no complete answer to the immoral paradox, "My performance of social duty is good not for me but for others," concludes that our cosmos of duty is in reality a chaos, Prof. Bain thinks that we have here "a sad ending to a great work;" and he proceeds to give a solution of his own, which some may consider little more than a restatement of the difficulty. The next paper is a criticism of Mr. Sidgwick's chapter on "Intuitionalism," by Mr. H. Calderwood, who endeavours to show that Mr. Sidgwick has "largely failed in the attempt to give a clear and fair representation of intuitionalism." The editor, Prof Croom Robertson, reviews Mr. Jevons's "Formal Logic." He praises the ability, ingenuity, and even success with which Mr. Jevons has laboured to construct a brand-new system, but is compelled at the same time to maintain the superiority of the methods of the traditional logic.—Mr. Shadworth H. Hodgson continues the work of distinguishing between philosophy and science. His present paper, "As Regards Psychology," is delightfully hard reading.—"Philosophy at Cambridge," is treated by Mr. H. Sidgwick.—A short kindly biography of James Hinton is written by Mr. J. F. Payne.—Critical notices, reports, correspondence, &c., make up the number.

Memorie della Società Spettroscopisti Italiani, November, 1875.—Prof. Bredichin writes an article on the spectra of certain nebulæ relating how he has adopted the plan of computing the lines of the spectrum of the nebula with the Fraunhoffer lines of the sun. The spectrum of a Geisler tube of hydrogen is used as an intermediate means of comparison. The mean positions of the lines are 5003·9, 5957·9, 4859·2 respectively. The first two lines agree very closely with the iron lines 5005·0 and [illegible]—A comparison of the solar diameters as obtained by the spectroscopic and transit methods by Secchi, Tacchini, and Rayet. The mean of the spectroscopic observations gave a diameter 1·8 less than the latter method.

December 1875.—Father Secchi contributes a note on his researches on the distribution of heat on the solar disc. Prof. Ricco writes on the perception and persistence of the sensation of colours. He throws a spectrum on a screen by reflection from an oscillating mirror, so that the spectrum is moved in a direction at right angles to its length backwards and forwards, and the shape of the apparent envelope of the coloured band shows that yellow is the most rapidly perceived colour, and the others decrease towards the red and blue.—Prof. Oudemanns writes on a method of heliometric measurement on the occasion of the transit of Venus.—Prof. Fergola writes on the dimensions of the earth, and researches on the position of the axis of figure with respect to the axis of rotation.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 18.—"Picrorocellin," by John Stenhouse, F.R.S., and Charles Edward Groves.

"On the Polarisation of Light by Crystals of Iodine," by Sir John Conroy, Bart., M.A. Communicated by A. G. Vernon Harcourt, Lee's Reader in Chemistry in the University of Oxford.

"Absorption-Spectra of Iodine," by Sir John Conroy, Bart., M.A. Communicated by A. G. Vernon Harcourt, Lee's Reader in Chemistry, University of Oxford.

Linnean Society, May 4.—Mr. G. Bentham, vice-president, in the chair.—Mr. G. Dawson Rowley and Mr. G. H. Parkes were elected Fellows of the Society.—Two foreign *savans* were chosen to fill the vacancies caused by death among the honorary members.—Mr. H. Trimen called attention to the photograph of a remarkable example of fasciated inflorescence occurring in *Fourcroya cubensis*, Haw. The specimen, coming under the observation of A. Ernst, of Caraccas, is recorded as 6½ feet high and 4 feet wide.—On behalf of Dr. Anderson there were shown specimens demonstrating the extraordinary diminutive eye of the Indian River Whale (*Platanista gangetica*), which animal to all intents and purposes must be well nigh blind; and likewise specimens of grasses (*Ischæmum rugosum* and *Paspalum scrobiculatum*) obtained from the stomach of the same creature, probably residual digesta of fish eaten by it.—Dr. Cobbold read a paper on Trematode parasites from gangetic dolphins. Three species were lucidly described, viz., *Distoma lancea*, *D. campula*, and *D. Andersoni*. The first of these was procured from the short-snouted Dolphin (*Orcella brevirostris*), a form more frequently captured in the Indian river estuaries. The last mentioned is entirely new to science. It and that immediately preceding (formerly designated *Campula oblonga*) were both obtained by Dr. J. Anderson from different specimens of the fluviatile Cetacean (*Platanista*). The special interest attached to the parasites in question may be thus summarised. 1. The circumstance of being obtained from Cetacean hosts not previously known to be

infested by them ... *D. lanca* and *D. campula* have each only once before (forty and twenty years respectively) been seen by any observer, and in either case from a different kind of whale. 3. The localities whence hosts and the Entozoa have been procured being situated regionally thousands of miles apart. 4. Verification of statements based on prior limited data. 5. The completion of our knowledge respecting the morphology and arrangement of all their more important internal organs. The author went on to generalise regarding the aberrance of host not producing departure of parasitic type, the relative periodic frequency and effects of such lowly organisms in wild and domestic animals, and the close alliance of the Plumaria to the forms treated. Mr. W. T. Thiselton Dyer read a paper on the genus *Hoodia*, with a diagnosis of a new species. He distinguishes three forms, viz., *H. Gordoni*, *H. Currori*, and *H. [illegible]*, and shows that in certain respects the genus *[illegible]* presents a close alliance. In the peculiarities of structure and recognition of parts of the floral envelope of *Hoodia* the author holds opinions diverging from those of Mr. Bentham, who previously had but a limited opportunity of examining this rare and interesting group of African plants. Mr. W. Duppa Crotch read a paper on the migration and habits of the Norwegian Lemming. Specimens belonging to him and Mr. A. [illegible] Alston illustrated certain moot points in the economy of these animals. The Rev. M. J. Berkeley communicated a report on the fungi collected in Kerguelen Island during the stay of the Transit of Venus Expedition of 1874-5. [illegible] the Cryptogamic flora of the island appears [illegible] represented in so far as number of species is concerned. A note on *[illegible]*, an oddly coloured kind of Marten inhabiting Cabul, by Dr. J. Anderson, was announced.

Geological Society, May 10.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—W. [illegible], James [illegible], John William James, Mark Stirrup, and Charles Wilkinson were elected Fellows of the Society.—The following communications were read:—On some fossil reef-building corals from the Tertiary deposits of Tasmania, by Prof. P. Martin Duncan, F.R.S. The species described by the author were *[illegible]*, sp. n., *[illegible]*, sp. n., and a second species of *[illegible]*. Both these genera are composed of reef-building corals, and the species here described undoubtedly belonged to that category. They required the natural conditions peculiar to coral reefs. The author noticed the facts as to the distribution of land and water in the Australian region in Lower Cainozoic time which are revealed by the deposits belonging to that age, and indicated that although the insular distribution of the land may have been unfavourable to the growth of coral reefs, the existence of a suitable sea-temperature in the latitude of Tasmania is insufficiently explained. A single [illegible] of the old reef-building corals survives on the shores of Tasmania in the *[illegible]* [illegible], but all the other forms have died out. The coral isotherm would have to be 15° [illegible] south of its present position to enable reefs to flourish south of Cape Howe, and this could be caused only by a change in the arrangements of land and sea, and in the position of the polar axis. The author indicated the general arrangement of land which he seemed to have prevailed, and noticed that at that period and even earlier the coral isotherm of 74° reached fully 25° north of its present position in the portion of the globe antipodean to Tasmania, but it would seem to require more than mere geographical changes to account for the existence of important reefs in western, central, and southern Europe and in Tasmania synchronously. The flora underlying the marine Cainozoic deposits of Victoria indicate tropical conditions, as do the Echinodermata of the succeeding strata (described in the following paper). The fossil plants of the Arctic regions, from the Carboniferous to the Miocene epoch, give evidence of the existence of higher temperatures and of other conditions of light than those now prevailing, but were the polar axis at right angles to the plane of the ecliptic, and were there no greater node than at present, there would be equal day and night at all points. The difficulty is to account for the present position of the axis on this supposition, but the author suggested that the great subsidences of Miocene lands, the formation of the southern ocean, and the vast upheavals of northern areas at the close of the Miocene epoch, may have sufficed to produce the present condition of things.—On the Echinodermata of the Australian Cainozoic (Tertiary) deposits, by Prof. P. Martin Duncan, F.R.S. In this paper, after noticing the history of our knowledge of Australian Tertiary Echinida, the author gave a list of the species at present known, amounting in all to twenty-three, and described the following as new species:—*Leiocidaris australiae*, *Temnechinus lineatus*, *Arachnoides [illegible]*, *A. elongatus*, *Rhynchopygus dysasteroides*, *Echinobrissus australis*, *Holaster australis*, *Maretia anomala*, *Eupatagus rotundus*, and *E. [illegible]*. The author remarked upon the characters and synonymy of the previously known species, his most important statement being that the so-called genus *Hemipatagus* is in reality identical with the recent genus *Lovenia*, Gray, as clearly shown by fine specimens in his possession. The most marked genera of the existing Australian fauna are not represented, but are replaced by numerous Spatangoid ... three species, however, are identical, but two of these have a very wide range. Of the remainder, nine are allied to recent Australian species, mostly from the north of the continent; six are allied to European and Asiatic Cretaceous forms; five are closely related to Nummulitic types; and one species appears to belong to a peculiar genus, namely, *[illegible]*.—The Miocene fossils of Haiti, by Mr. R. J. Lechmere Guppy, F.G.S.

Anthropological Institute, May 9.—Col. A. Lane Fox, president, in the chair. In a paper with copious table, under the title of Prehistoric names of weapons, Mr. Hyde Clarke traced an early chapter in the history of culture showing that the names of weapons and tools were widely distributed among the aborigines of Africa, Asia, Australia, and America. He illustrated the archæological relation to the stone age by certain conformities between axe and knife and stone. In Africa, where some weapons [illegible] [illegible] as is known ... the evidence of names is strong in affirmation of its having passed through a stone epoch.—Canon Rawlinson read a paper on the ethnography of the Cimbri. There were two theories respecting them on this—the one that they were Germans, the other that they were Celts. The evidence on both sides was slight, and very nearly balanced. The majority of the early writers were in favour of the Celtic view. Cæsar, who pronounced the Cimbri to be German, may not have met with any of pure blood. Much would depend on the meaning of the term yellow hair and the reason for the employment of Celtic speech in the Cimbric camp. The name Cimbri has so near a resemblance to Cymry (the *b* in Cimbri being a usual Roman addition) that this was perhaps as good evidence as any in favour of the Celtic affinities of the race. On the whole Canon Rawlinson inclined to this view. A short communication from Prof. [illegible] describing the "Hunebedden," or stone monuments in Holland, was read by the Director, Mr. J. W. [illegible].

Entomological Society, May [illegible].—Sir Sidney Smith Saunders, C.M.Z.S., vice-president, in the chair.—M. Jules Lichtenstein, of Montpellier, was balloted for and elected a foreign member. The Rev. T. Hellins sent for exhibition various British Lepidoptera, recently submitted to M. Guenée for his opinion and determination. One of the most important was a *[illegible]*, bearing some resemblance to *[illegible]*, not known to M. Guenée, taken at Queenstown, flying over bramble blossoms, in July or August, 1872, by Mr. G. T. Mathew; it was also unknown, as European, to Dr. Staudinger.—Mr. Distant exhibited a series of six examples of the butterfly, *[illegible]*, Hewitson, from Costa Rica, showing a very considerable variation in markings to which the species is evidently liable. He also communicated some remarks on the *Rhopalocera* of Costa Rica, with descriptions of species not included in the Catalogue of Messrs. Butler and Druce, published in the "Proceedings of the Zoological Society" for 1874.—Mr. Douglas exhibited specimens of the Corozo Nut (*[illegible]*), the vegetable ivory of commerce, of which the interiors were entirely eaten away by a species of *Caryoborus* (one of the *Bruchidæ*). A specimen of the beetle was shown, with nuts, from the London Docks, which had been recently imported from Guayaquil.—The Secretary read a letter he had received from the Foreign Office Department, enclosing a dispatch from her Majesty's Minister at Madrid, relative to the steps taken to check the ravages of the locust in Spain. It appeared that considerable apprehension was felt in many parts of Spain that the crops of various kinds would suffer greatly this year from the locust, and the Cortes had already voted a large sum to enable the Government to take measures to prevent this calamity, and by a Circular addressed to the Provincial Governors by the Minister of "Fomento," published in the Official Gazette, they were directed to make use of the military forces stationed within their respective districts to aid the population in this object. It was stated that thirteen provinces were threatened with this plague.

Geologists' Association, April 7.—Mr. Wm. Carruthers, F.R.S., president, in the chair.—On the volcanoes of Iceland, with special reference to those mountains which have recently erupted, by W. L. Watts. The vast mass of the Vatna-Jokull rests upon a base of tuff and agglomerate traversed in many places by intruded basaltic and other lavas. This mountain and its immediate neighbours constitute the highest and probably the oldest part of Iceland, for its lava streams are in a state of ruin and decay unequalled in any other part of the country, and it is girt upon its southern base by sea-cliffs, which must have been washed by the ocean when many other parts of Iceland were under water, unless a very serious depression has taken place since the southern outlying hills of the Vatna and Skaptar Jokulls were washed by the sea. The fires in the Vatna are not yet extinct. Crossing the deserts to the north of the Vatna Jokull, on the west is a large tract of lava, the greater part of which has flowed from Skaldbreith, whilst in front rise the Dyngjufjoll or Chamber Mountains, the volcanoes which caused so much damage to the north of Iceland last spring. These mountains are composed of palagonitic agglomerate, and are in many places traversed by dykes and masses of lava, whilst numerous protruding scoriaceous crags suggest that lava streams may lie beneath. The sides have been fissured and cracked by the violent earthquakes which preceded the eruption of last spring. In the latitude of 65° 45′ N., and extending eastward towards the sea shore, the country was found to be strewn with a light vitreous pumice, very vesicular and assuming most beautiful shapes. The crater from which this was ejected is situated in the south corner of the Askja (oval wooden casket), the name given to an elevated piece of land enclosed upon all sides but the north-east by semi-detached sections of mountains. The fissures in this volcano were still in active eruption, sending forth vast volumes of steam, a dark granulated fetid earth which occasionally fell around in showers, and a little water. Copious floods of water had flowed down the sides of the volcano; this is the more remarkable, as the Dyngjufjolls are neither glacial nor snow-capped mountains. The Oskjagja (chasm of the oval wooden casket) is, moreover, at least thirty-eight geographical miles from the lake of Myvatn and forty-five from the nearest glacier. The second centre of recent volcanic activity is situated in the Myvatns Oræfi, where the volcanic fires first made their appearance last year. After the violent earthquakes which at Christmas, 1874, shook the north-east of Iceland, a fissure twelve miles in length, and varying from one to thirty feet in breadth, opened in the west portion of the Myvatns Oræfi, and commenced to eject lava from fourteen or fifteen different points. Many of the smaller fissures formed by these earthquakes cast up stones and ashes, and lava welled up through them. The great discharge of lava, however, was from the great fissure which formed a lava stream some thirteen miles in length, and varying from one to three in breadth; it has overflowed an older lava stream which had issued from a vent in the Myvatns Oræfi, called the Svinagja. This fissure broke out again in March, and continued in a state of intermittent activity until the following April. The lava is basaltic, and differs from the ancient streams only in its not containing olivine. The fundamental rock of Iceland is the palagonitic tuff of subaqueous origin, disturbed and at times metamorphosed by enormous masses of amygdaloidal basaltic lava; these are overlaid by subaerial lava streams, pumiceous tuffs, and agglomerates which have been formed by debacles and atmospheric influences. Trachytic lavas occur but sparingly, the trachytic band supposed to bisect the island from Cape Langaness to Reykjanes being unsupported by investigation. Trachytes in a much altered condition have been found around and between Hekla and the geysers. Obsidian is seldom met with *in situ*. Mount Paul, however, in the heart of the Vatna Jokull, consists of this rock, whilst the pumiceous outburst of the Oskjagja must also be referred to it.

May 5.—Prof. J. Morris, F.G.S., vice-president, in the chair.—On the section of the chloritic marl and upper greensand on the northern side of Swanage Bay, by H. George Fordham, F.G.S.—Notes on the geology of the neighbourhood of Swanage, by W. R. Brodie.

Institution of Civil Engineers, May 9.—Mr. W. H. Barlow, vice-president, in the chair. The first paper read was on the construction of railway wagons, with special reference to economy in dead weight, by W. R. Browne, Assoc. Inst. C.E.—"The second paper read was on railway rolling-stock capacity, in relation to the dead weight of vehicles," by Mr. W. A. Adams, Assoc. Inst. C.E.

CAMBRIDGE

Philosophical Society, Feb. 28.—The following communication was made to the Society by Prof. Clerk Maxwell, on Bow's method of drawing diagrams in graphical statics, with illustration from Peaucellier's cell. A frame is a structure consisting of pieces jointed together at their extremities. In diagrams the joints are represented by points, and the pieces by straight lines joining the points. A diagram of stress is a figure such that the forces acting at each joint of the frame are represented in direction and magnitude by the sides of a polygon in the diagram of stress. When the diagram of stress is such that to the lines which meet in a point in the diagram correspond the sides of a polygon in the frame, the frame and the diagram are said to be reciprocal. Mr. R. H. Bow, C.E., F.R.S.E., in his "Economics of Construction in relation to Framed Structures," has pointed out a method of constructing reciprocal diagrams which applies to cases which I had formerly thought impracticable. Mr. Bow assigns a letter to each enclosed space of the frame, and also to each division of the surrounding space as separated by the lines of action of the external forces. When two pieces of the frame cross each other without being jointed, Mr. Bow treats them as if they were jointed. The forces at the point of intersection are represented by a parallelogram. In the diagram of stress the letters are placed at the points which correspond to the enclosed spaces of the frame. In Peaucellier's cell the three external forces acting at the centre and the two bracing points meet in a point in the diagonal through the other two angles of the rhombus. To every positive cell in which the centre is outside the rhombus corresponds a negative cell in which the centre is inside the rhombus, and if the point of concourse of the forces is outside the rhombus in one case it is inside in the other. Every line in the one figure is parallel to the corresponding line in the other, and the only difference is that the acute angles of the rhombus in one figure correspond to the obtuse angles in the other. These two frames have the same diagram of stress, so that the stress of corresponding pieces in the two frames is the same.

March 13.—Mr. Lewis communicated a comment [illegible] distance taken by him under rather peculiar circumstances last autumn, Oct. 8.

March 27.—Mr. Ammison read a paper on the relation of the [illegible] to the [illegible] in mammals. On vital force, by Mr. H. F. Baxter.

MANCHESTER

Literary and Philosophical Society, Feb. 22.—Mr. E. Schunck, F.R.S., president, in the chair.—Notes on a collection of apparatus employed by Dr. Dalton in his researches, which is about to be exhibited (by the Council of the Literary and Philosophical Society of Manchester) at the Loan Exhibition of Scientific Apparatus at South Kensington, by Prof. Roscoe, F.R.S.—A letter from Mr. Arthur Wm. Waters, dated Naples, Feb. 9, 1876, was read by Mr. Baxendell, giving some account of the Naples Zoological Station.—On glacial action in the valley of the Wenn, &c., by Prof. F. S. Allis.

Feb. 29.—E. W. Binney, F.R.S., in the chair.—An account of some early experiments with ozone and remarks upon its electrical origin, by J. P. Dancer, F.R.A.S.—Results of rain-gauge observations made at Eccles, near Manchester, during the year 1875, by Thomas Mackereth, F.R.A.S.

March 7.—Mr. E. Schunck, F.R.S., president, in the chair.—Mr. R. S. Dale exhibited specimens of crystals of sulphate of lead found in alum [illegible].—On the degree of accuracy displayed by druggists in the dispensing of physicians' prescriptions in different towns throughout England and Scotland, by Mr. William Thomson, F.C.S.

March 13.—Prof. W. Boyd Dawkins, F.R.S., in the chair.—Mr. Charles Bailey exhibited a series of slides illustrating similarities of structure in Dicotyledonous and Monocotyledonous stems. Mr. R. D. Darbishire, F.G.S., exhibited a series of specimens of very young *Plaice* (*Platessa vulgaris*, Cuv.), showing, (1), the two eyes on each side of the vertical plane, (2), the removal of the eye from the under side to the dorsal edge, (3) the appearance of both eyes on the one (upper) side of the fish. He also communicated some notes made during a visit in the past summer to the Swedish shell beds of Uddevalla and the neighbouring district, and exhibited a collection of the fossils of remarkable extent and beauty. List of shells found in Cymmeran Bay, Anglesea. Corrections and additions, by Mr. John Plant, F.G.S. Addenda and corrigenda.

March 21.—Mr. E. Schunck, F.R.S., president, in the chair.

—Dr. Arthur Schuster exhibited an interesting collection of objects brought by him from Siam and the Western Himalayas. —On a graphical method of drawing spectra, by Mr. William Dodgson.—Evidence to prove that a bone from the Windy Knoll, Castleton, named by Prof. W. Boyd Dawkins, F.R.S., "Sacrum of young Bison," is a sacral bone of the Cave Bear (*Ursus spelæus*), by John Plant, F.G.S.

April 4.—Mr. E. Schunck, F.R.S., president, in the chair.—Prof. W. Boyd Dawkins, F.R.S., called the attention of the Society to the depreciation of silver which is now under the notice of a select committee of the House of Commons, and in connection with this called attention to the enormous mining wealth of the Nevada silver-mining district, a part of which he had had the opportunity of examining last autumn.—On some isomerides of alizarine, by Edward Schunck, F.R.S., and Dr. Hermann Roemer.—Prof. Boyd Dawkins, F.R.S., said with reference to the Windy Knoll bone, spoken of by Mr. Plant at the last meeting, that he had re-examined the evidence, and consulted Mr. Davis, of the British Museum, and found that he was mistaken in referring it to bison. The evidence of the jaws and teeth proves that the bear of Windy Knoll is not the cave, but the great fossil grizzly bear (*U. ferox fossilis* = *U. priscus*). as may be seen by a reference to the Quart. Geol. Journ., Lond., 1875, pp. 251-2.—The Eucalyptus near Rome, by Dr. R. Angus Smith, F.R.S., V.P.

April 18.—Annual General Meeting. — Mr. E. Schunck, F.R.S., president, in the chair.—The number on the roll on April 1, 1876, was 166.—Mr. Edward William Binney, F.R.S., F.G.S., was elected President.—Mr. W. E. A. Axon read a note on a church bell, at North Wooton, Somersetshire, dated A.D. 1265, in Arabic numerals, and on a MS. dated A.D. 1276, in which they are freely used.

VIENNA

Geological Society, March 7.—M. F. Karrer examined, together with M. Linzow from Odessa, the limestones and lime-sand beds of the environs of Odessa, and found that nearly the whole mass of them is composed of Foraminifers belonging to the genus Nubecularia, which attach themselves to various other bodies, and therefore appear in many different forms.—Director Ruecker stated the most recent results obtained concerning the division of the coal-strata of Ajka, in Hungary, and presented to the Society a rich collection of fossils from this country.—M. F. Posépny referred to the salt-pits of Bex, near Geuf, and argues that neither the salt-beds of the Alps nor those of other countries are bound to a fixed geological horizon.—Dr. R. Hornes on the remains of Anthracotherium [illegible] Zovencedo.

PARIS

Academy of Sciences, May 15.—Vice-Admiral Paris in the chair.—The following papers were read:—Meridian observations of small planets at the Greenwich and Marseilles Observatories during the first three months of 1876; communicated by M. Le Verrier.—Note on the theoretical and experimental determination of the relation of the two specific heats in perfect gases whose molecules are monatomic, by M. Yvon Villarceau. In the ideal case where each gaseous molecule consists of only one atom, the relation of the two specific heats would be independent of the chemical nature of the gas, and equal (the author showed) to 1·666. Now MM. Kundt and Warburg have lately obtained for mercury vapour the number 1·67. He suggests the possible existence of other monatomic gases. M. Berthelot reserved his assent to the conclusions regarding mercury vapour.—On a working model of a new system of navigation locks, applicable specially to cases where the surfaces of water of the canals are very variable, by M. de Caligny.—Second note on the bitter lakes of the Isthmus of Suez, by M. de Lesseps. Notwithstanding the solution of the bank of salt in the middle, and the evaporation, the saltness diminishes. This must be due to currents, produced through difference of density between the water of the lake and that of the extremities of the canal; the heavy water flows to the sea, while the surface currents bring in water that is less salt. Hence an orifice of small section may suffice to prevent large sheets of salt water, though far from the sea, being concentrated by the heat.—Study of several questions relative to the Suez Canal, M. de Lesseps. *Inter alia*, rain now falls at least twice a month; during the construction of the canal, previously to 1870, M. de Lesseps observed rain not more than once in the year.—On the danger of introduction of certain American vines into the vineyards of Europe, by M. Marès. This is on account of the phylloxera found in galls on the leaves of American vines.—Mineralogical and geological researches on the lavas of the dykes of Thera, by M. Fouqué. This memoir furnishes new data on the distinction of felspathic species, the simultaneous presence of several triclinic felspars in one rock, the structure of lava at the moment of effusion, and the bedding and production of tridymite in volcanic rocks.—On the phylloxera issue of the winter egg, by M. Boiteau. —Another note on the subject, by M. Lichtenstein.—On the presence of phylloxera in submerged vines, by M. Trouchaud.—On the effects produced by absence of cultivation at the surface of the soil, in vineyards attacked by Phylloxera, by M. François.—Ephemerides of the planet 162, by M. Rayet.—On determination of the temperature of solidification of liquids, and particularly of sulphur, by M. Gernez. The point of solidification is sometimes substituted for the point of fusion, being supposed identical with it; but the determination may be vitiated by phenomena of superfusion. M. Gernez utilises these phenomena to determine the temperature of solidification with great precision. He shows how the temperature of solidification varies in the different kinds of sulphur; only insoluble sulphur being constantly solidified at one temperature, 114°·3, whatever the temperature at which it has been fused.—On calorific spectra, by M. Aymonnet. He used a Bourbouze lamp, and a refracting system of flint. The heat maximum approaches the less refrangible part of the spectrum in proportion as the temperature of the source decreases. Flint becomes less diathermanous as the temperature falls; a solution of iodine in chloroform, more diathermanous. (The distribution of heat in the spectrum is indicated by numbers.)—On the presence of selenium in refined silver, by M. Debray. It is nearly always present, and comes from the sulphuric acid used in refining.—Chemical researches on vegetation (continued). Functions of leaves. Origin of carbon, by M. Corenwinder. Not only can leaves acquire carbon by their surface, but they can assimilate the carbon contained in the carbonic acid which circulates in their tissues.—On the heart of Crustacea, by M. Dogiel. The muscular bundles of the pericardium act in the opposite direction to those of the heart itself (they are dilators). The blood of Crustacea is to be considered as lymph, and their heart a lymphatic heart; its movements depending on the action of the nervous system on the muscular elements.—The limbs of the aquatic Salamander, fully extirpated, are not regenerated; note by M. Philipeaux. The basilar bones must be completely removed.—On the signification of the filament of the stamen, by M. Clos. He thinks it the analogue, not of the petiole, but of the nervure or median portion of the petals.—On the crystalline system of several substances presenting optic anomalies; theory of crystalline groups; explanation of dimorphism, by M. Mallard.—On a new mineral from the Pyrenees, by M. Bertrand. This, called Friedelite, is a hydrated silicate of protoxide of manganese.—On the flora of the sandstone of Fontainebleau, by M. Contejean. -On the antiseptic properties of borax, by M. Bedoin.--On a new motor based on the elastic force of solid bodies, by M. Arnaudeau.

CONTENTS

THURSDAY, JUNE 1, 1876

SCIENTIFIC WORTHIES

VIII.—CHARLES WYVILLE THOMSON

CHARLES WYVILLE THOMSON was born at Bonsyde, a small property in Linlithgowshire, which had been long in his family, on the 5th of March, 1830. All his early associations were with Edinburgh; his father was a surgeon in the East India Company's service, and spent most of his life abroad, but his grandfather was a distinguished Edinburgh clergyman, and his great grandfather was "Principall Clerk of Chancellary" at the time of the rebellion of 1745.

Wyville Thomson got most of his schooling at Merchiston Castle Academy, at that time under the excellent management of Mr. Charles Chalmers, brother of the famous divine. He left school and began the medical course in Edinburgh University in the year 1845. After studying for three years he fell into somewhat delicate health from overwork, and while still scarcely more than a lad, in 1850, to gain a year's rest, he accepted the lectureship on botany in King's College, Aberdeen. In the following year he was appointed lecturer on the same subject at Marischal College and University, which University conferred on him the degree of LL.D. He at this time was an indefatigable worker among the lower forms of animal life, and published several papers on the Polyzoa and Sertularian zoophytes of Scotland. Even at this time some of his philosophical speculations as to the development of certain Medusoid forms attracted notice, though they appear to have been considered too daring by Johnston, of Berwick on Tweed, and Edward Forbes. What would these worthies say, if they were living now, about the study of Ontogenesis as it at present exists amongst us?

Towards the close of 1853 a vacancy arose in the Professorship of Natural History (Botany and Zoology) in the Queen's College, Cork, owing to the resignation of the Rev. W. Hincks, F.L.S., and on August 26 Wyville Thomson received the appointment. He had, however, hardly settled down to the duties of this professorship, when a vacancy occurred in the Professorship of Mineralogy and Geology in the Queen's College, Belfast, by the resignation of Fred. M'Coy, who had been elected to one of the professorships in the New University of Melbourne. Wyville Thomson applied to be transferred to the Belfast chair, and was appointed thereto in September 1854.

The next five years were years of busy work for him. He added to courses of lectures on Geology and Mineralogy, he laid the foundation and built up a good deal of the superstructure of the present excellent Museum of the Queen's College, Belfast. In addition to many papers on zoological subjects, published by him at this date, we may mention one on a genus of Trilobites, read before the London Geological Society, and on a new fossil Cirriped, published in the "Annals of Natural History."

The study of fossil forms without a good knowledge of existing forms is in itself most useless, and a palæontologist of this sort is after all little more than a cataloguer; such was not Wyville Thomson. At this time, one most interesting group of the Echinodermata—the Lily Stars—attracted his attention, and while investigating the immense assemblage of extinct forms belonging thereto, he determined to know all that could be known about the life history of the few living forms. True, the illustrious Vaughan Thompson had some thirty years previously discovered and described a British Pentacrinus, and had determined that it was but the young stage of our common Rosy Feather-star; but a great deal remained to be done ere the history of even this form was complete, and it was not until the close of 1864 that Wyville Thomson's researches were sufficiently advanced to enable him to lay them before the Royal Society. They have since been published in the volume of the Philosophical Transactions for 1865, and it is not too much to say that this memoir will ever be a witness of the author's acute and accurate powers of research. The illustrations are all from exquisitely finished sketches by the author, and show a most enviable power of drawing, an art almost indispensable to the naturalist. These investigations on the pentacrinoid stages of Comatula were but part of a series of observations on the genus Pentacrinus itself, and Wyville Thomson amassed a lot of material with the object of writing a memoir on the group.

About 1864 the son of the illustrious Michael Sars, Professor of Zoology in the University of Christiania, was one of the Acting Commissioners of Fisheries for Norway, and as such was engaged in a series of scientific investigations as to the fisheries of the Lofoten Islands situated on the north-west coast of Norway. One day, dredging in water about 300 feet deep, for the purpose of determining the condition of the sea-bed, he obtained a number of specimens of a strange Crinoid, which at once struck him as being an immature pentacrinoid stage of *Comatula Sarsii*, with which he was familiar.

Here it is but right to mention that almost up to this date, men of science seemed to have made up their minds that life did not and could not exist below a certain depth of the sea. There were, according to Edward Forbes, five zones of depth: 1st, the littoral zone, between low and high water marks; 2nd, the Laminarian zone, from low water to a depth of fifteen fathoms; 3rd, the Coralline zone, from the fifteen fathom line to a depth of fifty fathoms; and 4th, the zone of deep-sea corals, extending from the edge of the Coralline zone to an unknown lower limit. In this region, as we descend deeper and deeper, its inhabitants become more and more modified and fewer and fewer, indicating our approach towards an abyss where life is either extinguished or exhibits but a few sparks to mark its lingering presence." Though the very general belief entertained by naturalists was that the depths of the sea were destitute of life, yet from time to time remarkable specimens were wont to be brought up from very great depths, and the occurrences, some of which were known to Forbes, had the evident effect of making him, during the latter part of his life, write cautiously on the subject. The reader who would care to know all that is known as to the records of the existence of life up to 1865, will find a full account thereof in Wyville Thomson's "Depths of the Sea."

G. O. Sars lost no time in announcing to his father his interesting discovery, and, acting on Prof. Sars's advice, he

went on dredging at depths of from 700 to 800 feet, finding an abundance of animal life. In the meanwhile the elder Sars, knowing that Wyville Thomson was working on the subject, sent him word of his son's discovery, of the significance of which he was still in doubt, and invited him to Christiania to see the specimen. He went, and on going over the matter together they came to the conclusion that the new Lily Star seemed to be closely related to a genus called *Bourgueticrinus*, a well-known fossil, and was consequently a degraded form of the family Apiocrinidæ. This was a startling discovery; it seemed now almost certain that there had been found not only a living representative of a long lost group, but a form that might be regarded as having lived on from the great Chalk epoch even into ours. In the train of thought thus excited, we think we see the material for speculation, then a fixed determination to prove—is this speculation true? then the trial trip in the *Lightning*, the more extended survey in the *Porcupine*, and lastly, all the brilliant results of the most remarkable voyage of discovery ever made, in the *Challenger*. It is not right to anticipate, and in pursuing our sketch we must not forget to mention that in 1860 Dr. Dickie, who was then a colleague of Wyville Thomson's as Professor of Natural History in the Queen's College, Belfast, was appointed to the Chair of Botany at Aberdeen, and at first temporarily and afterwards permanently, Wyville Thomson lectured on zoology and botany, becoming thus in very deed Professor of Natural History in the Queen's College, Belfast.

Prof. Wyville Thomson was, however, something besides a mere enthusiastic biologist; he was not merely content with rapidly increasing the zoological treasures of the Queen's College Museum; he did more. By interesting himself not only in what concerned the working of the College, but even in the welfare of the town in which it was located, he soon gathered round him a host of intelligent and warm-hearted friends. In social life it was but an accident that would reveal the Biologist, and one witnessed only the general culture and the artistic taste of a well-bred man. On one occasion of great moment in the history of the Queen's University in Ireland, Wyville Thomson's influence was felt, as we believe, for good. In 1866 a Supplemental Charter was given by the then Government to the Queen's University to enable it to confer degrees on students who might come up from any College that might be recognised as such by the Senate of the Queen's University. It seems hard to believe that such a charter should have been granted, for it might have given to any large school a position of equality to the three Queen's Colleges, and so have practically destroyed all middle-class education in Ireland. Wyville Thomson saw that the interests of education were at stake, and with commendable promptness and immense energy he initiated the formation of a committee and the collection of a sum of several thousands of pounds to try the validity of the new Charter in a court of law. In this the committee were successful, for the Charter was rendered inoperative by an injunction granted in 1867, after long and protracted arguments, by the then Master of the Rolls in Ireland.

Wyville Thomson was vice-president of the jury on raw products at the Paris Exhibition in 1867; he took the lead in organising the very flourishing School of Art in Belfast under the Science and Art Department, and was the first chairman of the Board of Directors. He is a Conservative in politics, and a magistrate and Commissioner of Supply for the county of Linlithgow.

In 1868 Dr. Carpenter, at that time one of the vice-presidents of the Royal Society, paid Prof. Wyville Thomson a visit in order that they might work out together the structure and development of the Crinoids. As the friends discoursed about these Lily stars, Wyville Thomson told Carpenter of his own firm conviction that the land of promise for the naturalist, indeed the only remaining region where there were endless novelties of most extraordinary interest, was the bottom of the deep sea; here were treasures ready to the hand which had the means of gathering them, and he urged him to use his influence at head-quarters in London to induce the Admiralty to lend to science, for a time, some small vessel properly fitted with dredging gear and the other necessary scientific apparatus, so as to definitely settle all these weighty questions. The Admiralty gave their sanction to the use of a Government vessel for the investigation, and the surveying ship *Lightning* left Oban for a cruise in the North Atlantic Ocean in August, 1868, returning to Oban by the end of September. For an account of this cruise we must refer to the "Depths of the Sea." The results of the *Lightning* expedition were fairly satisfactory. It was shown beyond question that animal life was varied and abundant at depths in the ocean down to between 600 and 700 fathoms; and it had been determined that great masses of water at different temperatures were moving about, each in its particular course; and, further, it had been shown that many of the deep-sea forms of life were closely related to fossils of the Tertiary and Chalk periods.

In 1869 the Admiralty once again acceded to the request of the Royal Society, and assigned the surveying vessel *Porcupine* for a survey to extend from May to September, 1869. The 1869 survey divides itself into three sections; the first when the *Porcupine* surveyed off the west coast of Ireland, Mr. Gwyn Jeffreys being in scientific charge; the second in the Bay of Biscay, in charge of Wyville Thomson; and the third, in which the track of the *Lightning* was carefully worked over, and all previous observations were duly checked.

Once again, in 1870, the Admiralty placed the *Porcupine* at the disposal of the Royal Society, and it was arranged that the year's expedition should be divided as in 1869, info cruises. Mr. Gwyn Jeffreys was to undertake the scientific direction of the first cruise from Falmouth to Gibraltar, and Wyville Thomson and Dr. Carpenter were to relieve him at Gibraltar, and to superintend the survey of the Mediterranean. Unfortunately a severe attack of fever prevented Wyville Thomson from joining the *Porcupine* at Gibraltar, and Dr. Carpenter took charge of the scientific arrangements.

In 1869 Wyville Thomson was elected a Fellow of the Royal Society.

In 1870 Dr. Allman resigned the Professorship of Natural History in the University of Edinburgh. Wyville Thomson was a candidate for the vacant chair, and amid the hearty congratulations of all men of science he was elected, vacating the chair in the Queen's College, Belfast, to which Dr. Cunningham was appointed.

On the return of the *Porcupine* from her last cruise, so much interest was felt in the bearings of the new discoveries upon important biological, geological, and physical problems, that a representation was made to the Government by the Council of the Royal Society, urging the despatch of an expedition to investigate each of the great oceans, and to take an outline survey of that vast new field of research, the bottom of the sea. The proposition of the Royal Society met with great and general support, and the *Challenger* was fitted out as England never before fitted out a vessel for scientific research.

The University of Edinburgh having given their consent, Prof. Wyville Thomson accepted the post of Director of the Civilian Staff; for this post none could have been better qualified; through his energy was it that this question of what lived in the ocean depths came to be investigated at all; the practical experience he had now gained could not be better utilised, while the subjects to be worked out were all within his reach. Able as a biologist to hold a high position, he combined with this more than an ordinary knowledge of chemistry, mineralogy, and geology, a knowledge far more than enough to enable him to encourage and sympathise with the labours of his staff.

The *Challenger* has now returned to our shores, her mission worthily accomplished, her officers and crew in the best of health and spirits.

All England welcomes Prof. Wyville Thomson back again, and thanks him for his voluntary exile of three and a half years from home and wife and friends for Science sake; and while we congratulate him on having laid a new realm at our feet and on having given us new food for thought, may we express in addition the hope that he will not long delay to give to the world the narrative of a cruise novel in its conception, successful in its results, and destined to live long in story.

THE CRUELTY TO ANIMALS BILL

IT is important that those who understand the national importance of science, as well as those who know how completely the art of medicine depends upon physiology should agree upon a common defence, now that both are so seriously threatened by legislation.

We do not think that scientific investigators can fairly claim to be entirely free in their choice of methods, on account of the importance of their objects, the purity of their motives, or the respectability of their character. Claims to absolute immunity from the interference of the State were maintained on precisely the same grounds by Churchmen in the Middle Ages, and the result proved how dangerous it is for any class of men to seclude themselves from the healthy atmosphere of free criticism and from contact with the popular conscience. A much better plea might be found in the small number of physiologists in this country, and in the important fact that, after many months of agitation and invective, their enemies were not able to bring before the Royal Commission a single authentic instance of cruelty. Still, considering the strong popular feeling on the subject, there are probably few who will deny that some legislation is necessary, if only to save physiologists spending their whole time in writing newspaper articles and going on deputations to Ministers.

What scientific men have a right to demand is that any regulations made should interfere as little with their legitimate objects as is compatible with the purpose of legislation. No one except a few obscure fanatics pretend that it is never lawful to subject animals to pain, or even to death, for self-preservation forbids such a rule; and no one can maintain that it is right to bleed calves and swallow oysters alive, for luxury, to geld horses for convenience, and hunt hares to death for sport, and yet that it is wrong to give one animal a disease that we may learn how to prevent or cure the same disease in thousands, or to perform a well-considered experiment which will certainly increase our knowledge of the laws of our being, and, more or less probably, tend to the relief of human suffering.

It is, therefore, of great importance that none of the objects which justify experiments on animals should be sacrificed in the effort to save the rest. Teachers of physiology in large and well-equipped schools might be content with a registration Bill which would leave them unmolested and forbid all research to outsiders; physicians and surgeons might demand liberty to do anything they choose which has a direct and immediate bearing on the relief of human suffering, and this appeal to self-interest would probably always be successful; independent investigators might see, without complaint, the teaching of physiology reduced to a study of words and opinions, and the advance of medical knowledge brought to a standstill, so long as they were left in peace. But such short-sighted narrowness would bring its own punishment. The results of independent research can only be obtained by those who have themselves been trained in genuine workrooms and can only be properly criticised by a properly instructed audience. Teaching without any attempt at original observation soon becomes lifeless and inexact; and medicine is far less indebted to experiment for the knowledge of the effect of certain drugs or operations, than for the broad basis of demonstrated facts as to the functions of the healthy organism on which all rational attempts to remedy them when disturbed must depend.

The scientific objects, then, which must, if possible, be protected from the mischievous Bill now before Parliament are, first, freedom of original investigation by competent persons; secondly, freedom of teaching by necessary demonstrations; and thirdly, freedom of experiment with the definite aims of the practical physician.

The best method of securing these objects while preventing the stain of cruelty from debasing the fair fame of science, would probably be that indicated by the Report of the Royal Commission. Laboratories would then be licensed under the control of responsible persons. Special certificates would be granted to competent investigators who, from distance or other causes, were not able to make use of these laboratories. The advance of sound physiological knowledge as well as the direct prevention or cure of disease, would be recognised as a legitimate object of experimental inquiry. The general condition of the licence or certificate would be that every experiment on a living animal should be rendered free from pain by the skilled use of chloroform (or other anaesthetic better adapted to the animal), except when this would defeat the object of the inquiry, and happily these exceptions

need be very few. Lastly, inspectors might fairly be appointed to see that not only in the actual experiments, but in the feeding, housing, and general treatment of the laboratory animals there was neither parsimony nor carelessness. The licence would be given on suitable recommendation by the Home Secretary, with power of revoking it for abuse, subject to appeal, as suggested in the Royal Commissioners' Report.

Under such an Act physiologists might fairly be expected to make it a point of honour that its provisions were fully carried out in spirit as well as in letter. The framers of the present Bill, by their disregard of physiology as an independent science, to be taught like any other, do their best to render its progress impossible; while, by their absurdly minute limitations, they would make original research almost as impossible as efficient teaching, and deprive the art of medicine of its only safe foundation.

The efforts of all who care for the advance of human knowledge or the alleviation of human misery should be directed to bring the scope of the Government Bill back to that indicated by the Report of the Royal Commission.

THE SCIENCE OF LANGUAGE

Language and its Study. By Prof. Whitney; edited by Dr. R. Morris. (London: Trübner and Co., 1876.)

Leaves from a Word-Hunter's Note-book. By the Rev. A. S. Palmer. (London: Trübner and Co., 1876.)

The Aryan Origin of the Gaelic Race and Language. By the Very Rev. U. J. Bourke (London: Longmans, Green, and Co., 1875.)

THESE three books are very fairly characteristic of the present position of comparative philology. The first is a reprint of the first seven chapters of Prof. Whitney's well-known work on the science of language, and has been admirably edited by Dr. Morris with notes and introduction, with special reference to a scientific study of English. The second is just what it professes to be, extracts from a commonplace book on the etymology of various words, and it illustrates very well the influence exercised by a comparative treatment of language upon what used to be the pastime of literary *dilettanti*. Mr. Palmer's derivations have been traced with full regard to the scientific method, and besides being accompanied by a wealth of quotations, rest for the most part on a secure foundation. "The Aryan Origin of the Gaelic Race," again, is one of those books which a few years back would have teemed with the wildest vagaries; the author, it is plain, has little critical judgment, but a diligent study of works like those of Zeuss or Max Müller has kept him in the right path, and though he startles us now and then with such assertions as that the Aryan is "the primeval language of man," or that "there had been only seventeen letters in Greek at the earliest period," his views are in general just and sound. We may doubt whether his theory of the Pagan origin of the Round Towers will be widely accepted, and complain of his prolixity, but the book is a striking example of the extent to which a knowledge of Comparative Philology has spread, and the wholesome influence its principles have exerted.

When we consider that the science of language is a science of not more than fifty years' growth, as well as the vast amount of details that had to be collected and classified before its creation became possible, its present advanced condition must be a matter of surprise. No doubt there is still very much to be done; some of the main questions connected with the study of language still remain unsettled, and new questions are starting up that will have to be answered hereafter. It is even possible that fresh knowledge and investigation will modify some of the hypotheses which have been accepted as fundamental truths.

Thus it might have been thought that the first question to be settled would be whether the science is to be included among the physical or the historical sciences, and yet this is even now a matter of dispute. There is much to be said in favour of both views. If we look merely to the fact that it lays down the laws in accordance with which thought endeavours to express itself in speech, it must be regarded as a historical science; if on the other hand, we consider that thought can only be expressed in speech by the help of physiological machinery, we are bound to class it among the physical sciences. If we make phonology not only the beginning, but also the end of linguistic science, linguistic science will differ but little from physiology in aim as well as in method; but if we remember that the various sounds which it is the province of phonology to determine and classify do not become language until they embody a meaning, the science of language will have to be grouped among those other sciences which deal with the history of human development. The same difficulty meets us again in the case of geology, which traces the history of the earth, and if with Prof. Whitney we prefer to regard the science of language as a historical science, while we call geology a physical science, it is because the element of mind enters more largely into the one, and the element of matter into the other. The laws which govern matter remain always the same; those which govern thought and life are modified by a process of internal development.

The science of language, otherwise called glotology or linguistic science, should, strictly speaking, be distinguished from comparative philology. The latter, by comparing words and grammatical forms within separate groups of languages, and thereby ascertaining the nature of these several groups and the laws which govern their growth and formation, provides the materials for the science of language. This takes the results obtained by comparative philology in the various species and genera or families of speech, and with the help of the comparative method determines from them the laws of speech generally. Inasmuch as we have to compare phenomena belonging not only to the same period, but also to different periods in the history of language, that part of linguistic research which is not purely phonological has to assume a historical character, so that to discover the causes of the phenomena is to explain their origin and process of growth. Now the phenomena of language are words and sentences, phonetic utterances, that is, which are or have been significant.

Perhaps the most important result of the science of language has been the demonstration that even language, even those "winged words" over which men once fancied they had the most complete control, are as much subject

But we must not forget that the science of language is still a young science. Its followers are still engaged in laying its foundations and testing their strength. The problems that await solution are numerous and important. So far as our evidence goes at present, it tends to show that the languages of the world have sprung from an infinite number of separate sources, but it remains to be seen whether future discoveries will not reverse this conclusion. Then, again, there is the question of roots All comparative philologists admit that roots are the ultimate elements into which language can be decomposed, but it is still a question whether the roots discovered by the grammarian once formed a spoken language, or whether they are but grammatical figments which are the best representatives we can obtain of the early condition of speech. Equally disputed is the question whether the different classes of language—inflectional, agglutinative, polysynthetic, and isolating—are to be regarded as constituting separate streams of linguistic development from the first, or a single stream which has branched out into separate ones It is unquestionable that a large part of flection can be shown to have had an agglutinative origin, it is also unquestionable that the phenomena of isolation are to be met with in the inflectional languages, and the phenomena of flection in the isolating languages but it is asked whether this would have been possible if each class had not had a definite tendency to flection or isolation from its starting—a standard, that is, to which all foreign elements introduced into the language were made to conform Such are some of the questions which still remain to be answered, and if we are to judge from the rapid progress already made by the science of language, the answers will not be long in coming

A H SAYCE

OUR BOOK SHELF

Rudiments of Geology By Samuel Sharp, F S A, F G S Second Edition. (London Edward Stanford, 1876)

THE author of this little manual, which is designed for the use of schools and junior students, has evidently taken considerable pains to make his work fairly represent the existing state of geological knowledge He has moreover, succeeded in conveying in simple language an idea, not only of the conclusions attained, but of the processes of investigation and reasoning, followed by the geologist in his researches, and we regard the book as well adapted to introduce a beginner to the study of the science, and to prepare him for the profitable perusal of more extended treatises As compared with some of the similar introductory text books of the science, which have recently been published, Mr Sharp's manual labours under the disadvantage of being somewhat inadequately illustrated, for we find in it only a few diagrams and no figures of fossils This second edition, however, is certainly a considerable improvement upon the first, and the division of Physical Geology has received much more full and careful treatment, the extent of the additional matter being sufficient to increase the number of pages of the book from 126 to 204

South Australia its History, Resources, and Productions Edited by William Harcus Illustrated with photographs taken in the Colony Published by authority of the Government of South Australia (London Sampson Low and Co, 1876)

THE nature of this handsome volume may be learned from the fact that it has been prepared to accompany the specimens of South Australian products and industries sent to the Philadelphia Exhibition It contains a vast amount of the most useful information on nearly all matters connected with the colony, gives an excellent idea of its present condition, and is likely to be of great use to intending settlers. Mr Harcus, who edits the volume, writes also one half of it, treating of the social, political, and industrial aspects of the colony In a series of valuable appendices, Dr Schomburgk treats of the flora of South Australia, Mr Waterhouse of its fauna, Mr J B. Austen of mines and minerals, while Mr Josiah Boothby contributes a statistical sketch of the colony, and Mr Charles Todd treats of its observatory and meteorology There are two very useful maps, while the illustrations are nearly all good and interesting

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications*]

The Spelling of the Name "Papúa

I QUITE agree with Mr Whitmee's objections to English orthography of foreign words (see NATURE, vol xiv p 48), but in this case I intended to show at a glance to *non-linguistic* readers that the accent in the word Papua must be on the second syllable, and not on the first The Germans write Papua,' and pronounce Papua (as they pronounce Mantua,' "Padua, &c) This being wrong, and fancying that in England the same mistake is often made, I wrote "Papuon," which leaves no uncertainty in respect to pronunciation I confess that it would have been more convenient to retain 'Papua,' and remark in a note that the accent must be on the 'u In a linguistic work I should never have proposed 'Papuon," but it cannot be supposed that every reader of NATURE knows what Marsden pointed out in 1812 In German I write "Papúa, and perhaps the same mode would be the most convenient in English It is known that the French use Papou, the Dutch 'Papoea, the Malay Papuwah In these cases the pronunciation may not be questionable, as it is in German and English if written 'Papua

The most interesting point in Mr Whitmee's letter is no doubt the announcement of a comparative grammar and dictionary of all the principal Malayo-Polynesian dialects and those interested in these studies will certainly be anxious to receive such a valuable increase to their knowledge

Dresden, May 25 A B MEYER

New Zealand Prehistoric Skeleton

AMONG the "Notes in NATURE, vol xiii p 196, just come to hand you give an extract from the Order Paper of the Legislative Council of New Zealand concerning the remains of a supposed 'prehistoric man, regarding which a motion for an inquest was tabled by Mr Walter Mantell As you correctly report, this skeleton was excavated under my direction in the so called Moa-bone Point Cave, but it was not found in the lower beds containing Moa bones, but in a much more recent formation, and to which I assigned a comparatively modern date

You state that I hold strongly to the [illegible] of the deposit, but I [illegible] to conceive what ground you have for such an assertion and as I can only conclude that you received your information direct from New Zealand, I beg to forward you herewith for your perusal a copy of my paper reporting the excavation and my views thereupon

With regard to the motion itself, which was treated throughout the colony as a joke, it is sufficient to state that Mr Walter Mantell is the recognised jester of the Legislative Council, and that even science does not escape his attempted witticisms I may add that the Hon Dr Pollen, the Premier of the Colony, also treated the motion as a joke, and offered Mr Mantell the office of coroner for the proposed investigation

Although Mr W Mantell, F G S, stated, when speaking on his motion (see Hansard, 1875, p 548), that "*he relied on the fact that he was not a scientific man, and he did hope he would be able to go to his grave without* [illegible] *that disgrace* never-

theless, he is known to have his pet theories about the antiquity of the Moa, and is very impatient of any contradiction.

I have thought it right to offer this explanation in order to prevent your readers being misled on a subject of considerable scientific interest JULIUS VON HAAST

Canterbury Museum, Christchurch, N Z, March 14

Visibility of the Satellites of Uranus

THE question of the visibility of these satellites in telescopes of moderate dimensions has lately excited considerable attention, but it does not appear that the question can be settled by any amount of verbal discussion I take the liberty, therefore, to propose two test objects by means of which any one can, I think, satisfy himself whether he can see these satellites or not

1 The companion of Regulus, north, preceding, and distant about three minutes of arc, has itself a small companion, which was discovered by the late Prof Winlock Any one who can see this small companion may be certain that he can observe the two outer satellites of Uranus and the satellite of Neptune

2 The star of fifth magnitude, A Leonis, has a companion discovered at the Naval Observatory by Mr G Anderson Any one who can observe this companion can, I think, see the two inner satellites of Uranus when at their elongations

Of course in the case of such faint objects very much depends on the condition of the atmosphere, but the above tests are very nearly correct. A AIH HALL

Washington, May 14

Protective Resemblance in the Sloths

IN a note upon the above subject, dated December 29 1875, which appeared in vol xiii p 187 of NATURE, I omitted to quote a passage from a letter written by Dr Berthold Seemann to the late Dr J E Gray (dated April 1, 1871), with regard to a specimen of *Arctopithecus*, of a well marked green colour, obtained by the former naturalist in Nicaragua Of this Sloth he says, *inter alia* — It should be born in mind that it has almost exactly the same greyish green colour as *Tillandsia usneoides*, the so-called 'vegetable horsehair' common in the district, and if it could be shown that it frequented trees covered with that plant (a point I hope to ascertain during my next visit in June next), there would be a curious case of mimicry between this Sloth's hair and the *Tillandsia*, and a good reason why so few of these sloths are seen' (Note on the species of *Bradypodida* in the British Museum, by Dr J F Gray, F R S, *Proc Zool Soc*, May 2, 1871) It would be interesting to know whether Dr Seemann succeeded in solving this question, I am, however, not aware of any further reference made by him to this subject

I here take the opportunity of correcting two misprints in my former letter, both of them in the Latin quotations, viz, "cum' for "cum, after the word "vellera,' in the first, and "coque" instead of "eoque' after the word "possint, near the end of the second passage J C. GALTON

OUR ASTRONOMICAL COLUMN

THE SECONDARY LIGHT OF VENUS During the next few weeks a very favourable opportunity will be afforded to observers in these latitudes for further examination of the planet Venus, with the view to a satisfactory solution of what must yet be regarded as a *questio vexata*— the visibility of that part of the disc, which is unilluminated by the sun, as the planet approaches or recedes from the inferior conjunction.

The subject is treated in detail in a communication to the Bohemian Academy of Sciences, from Prof. Safarik of Prague, entitled "Ueber die Sichtbarkeit der dunklen Halbkugel des Planeten Venus,' which appears in *Sitzungsberichte der Böhmischen Gesellschaft der Wissenschaften*, July 18, 1873 The author has collected together the many scattered observations extending over upwards of one hundred and fifty years, and presents also an outline of the various explanations which have been put forward

The earliest mention of the faint illumination of the dark side of Venus is by Derham, in a passage in his Astro-Theology, to which attention was first directed by Arago. Derham refers to the visibility of the obscure part of the globe "by the aid of a light of a somewhat dull and ruddy colour." The observation is not dated, but appears to have been prior to the year 1714 A friend of Derham's is also stated to have perceived the same illumination very distinctly

The next observations are by Christfried Kirch, second astronomer of the Berlin Academy of Sciences, June 7 1721, and March 8, 1726, and were found in his original papers and printed in *Ast Nach* No 1586 The image on the first occasion was tremulous, but though he could hardly credit his vision, he appeared to discern the dark side of the planet In 1726 he remarked that the dark periphery seemed to belong to a smaller circle than the illuminated one Kirch observed with telescopes of sixteen and twenty six feet focal length, powers 60 and 100 Two other persons confirmed his observation in 1726

The next observation in order of date, was found by Olbers, in "Observationes Veneris Grypiswaldensis", cited by Schroter in his observations of the great comet of 1807 It was made by Andreas Mayer Professor of Mathematics at Greifswald on October 20, 1759, observed the meridian passage of the planet, then at south declination of 21°, with a six foot transit instrument by Bird, power not much over 50, and has the remark— "Pars lucida Veneris tenuis admodum erat nihilominus integer discus apparuit, instar lunae crescentis qua acceptum a terra lumen reflectit ' As Prof Safarik justly observes considering the circumstances under which Mayer's observation was made with the planet only from the sun, and not more than 14 above the horizon the phenomenon on this occasion must have had a more unusual intensity

It does not appear that Sir W Herschel at any time perceived the secondary light of Venus, though he remarked the extension of the horns beyond a semicircle

Von Hahn, at Remplin, in Mecklenberg, the possessor of excellent telescopes by Dollond and Herschel, was fortunate in viewing the dark side of Venus on frequent occasions during the spring and summer of the year 1793 and he is considered by Safarik to have witnessed the illumination of this part of the disk under more varying conditions than any other observer The light is described as grey verging upon brown. Von Hahn's observations were made with various instruments and at different hours of the day

Schroter, at Lilienthal, on several occasions between the years 1784 and 1795, had remarked in full sunshine the extension of the horns of the crescent many degrees beyond the semicircle, the borders of the dark hemisphere being faintly illuminated with a dusky grey light, but on February 14, 1806 ... he saw for the first time the whole of the dark side as he expressed it, "in aussersт mattem dunkeln Lichte The sharply defined contour had an ash coloured light the surface was more dimly illuminated Schroter in recording this observation, expresses his surprise that during the many years he had observed the planet, part of the time with his 27 feet reflector, with the full aperture of 20 inches, he had not previously perceived the whole of the dark side, but he was satisfied there was no illusion At this time one eighth of the diameter of Venus, about 45', was fully illuminated, the planet cast a very sensible shadow

Harding, observing at Gottingen on January 24 of the same year, with a 10 feet Herschelian reflector, power 83 and full aperture of 9 inches, saw the whole dark side of Venus shining with a pale ash coloured light, very distinctly perceived against the dark ground of the sky The appearance was too evident to allow of the suspicion of an illusion, it was the same in all parts of the field of

view, and under various magnifying powers. Altogether the phenomenon was as distinct as in the case of our moon. On February 3, 16, and 21 it was not seen, but on the evening of February 28, it was again prominently visible to Harding; the illumination was now of a reddish grey, "like that of the moon in a total eclipse." Yet on the same evening Schröter looked in vain for the phenomenon at Lilienthal, showing how cautiously negative evidence should be received.

Observations of the secondary light were made by Pastorff in 1822 and by Gruithuisen in 1825.

The *Monthly Notices* of the Royal Astronomical Society contain many observations since the year 1842 by Messrs. Berry, Browning, Guthrie, Langdon, Noble, Prince, and others. Mr. Prince had favourable views of the illumination of the dark side in September 1863. Capt. Noble's observations, as remarked by Prof. Winnecke in his notice of Prof. Safarik's memoir, do not appear to refer to the secondary light as it has been perceived by other observers. He mentions that the hemisphere unilluminated by the sun has to him "always appeared distinctly and positively *darker* than the background upon which it was projected," a statement which certainly gives the observations a distinctive character.

There are also observations of the secondary light by Lyman, at Yale College in 1867, and about the same time by Safarik at Prague, and in August, 1871, more decidedly. In September of the latter year the whole disk of Venus was seen by Prof. Winnecke as described in *Ast. Nach.*, No. 1863. This astronomer has since stated that notwithstanding he has observed the planet many hundred times during the last twenty-four years, he has only succeeded in perceiving this remarkable illumination of the dark side on two occasions; and it should be added that Dawes, Madler, and other eminent observers, have never detected it. We shall revert to this subject next week.

THE OBSERVATORY AT ATHENS.—The death is announced of Baron Simon von Sina, son of the founder of the Observatory at Athens, which has been successively under the direction of M. Bouris and Herr Julius Schmidt. The deceased Baron is mentioned as a liberal patron of this establishment, though not himself engaged in scientific pursuits, and Herr Schmidt writes doubtfully of the future of the Observatory. Every astronomer will entertain the hope that this most laborious and successful observer distinguished not only by his great work upon the moon, but for his numerous discoveries and observations of variable stars, his long and important series of observations of comets, of short period and otherwise, in which he has made excellent use of the advantages of his southern position, and many other valuable contributions to observational astronomy—may continue to hold, under favourable auspices, the direction of an establishment which his exertions have made so honourably known in the astronomical world.

THE LOAN COLLECTION CONFERENCES

OWING to the pressure on our space this week, we can only refer briefly to what has been done since our last notice at the Conferences in connection with the Loan Collection. We give, however, in another part of the paper the presidential addresses of Dr. J. Burdon Sanderson, F.R.S., in the Section of Biology, and of Mr. John Evans, F.R.S., in the comprehensive Section of Physical Geography, Geology, &c. We hope in early numbers to be able to give at some length the principal papers which have been read in the various sections.

On Thursday last the concluding meeting in the Section of Mechanics was held, when the following papers were read:—"On Prime Movers," by Mr. Bramwell, F.R.S.; "The Construction of Furnaces," by Mr. Hackney; "A History of Electric Telegraphs," by Mr. Preece.

The first meeting in the Section of Biology was held on Friday, when the papers of which we gave a list in our last week's notice were read. This Section met also on Monday, when the following papers were read:—

Dr. Royston-Pigott, F.R.S., on a "Microscope with Complex Adjustments, Searcher, and Oblique Condenser Apparatus;" Prof. Rutherford, F.R.S., "On a Freezing Microtome;" Prof. Flower, F.R.S., "On the Osteological Preparations exhibited by the Royal College of Surgeons;" Herr Prof. Dr. Donders, "Ophthalmological Apparatus;" Dr. M'Kendrick, "Acoustical Instruments;" Prof. Yeo, M.D., and Dr. Urban Pritchard, "On Microtomes."

On Tuesday the first meeting in the Section of Physical Geography, Geology, Mineralogy, and Meteorology, was held, when, in addition to the President's Address, the following papers were read:—

Mr. R. H. Scott, F.R.S., "Meteorological Instruments in the Loan Collection;" Mr. G. J. Symons, "The Measurement of the Rainfall;" Dr. R. J. Mann, "Lightning Conductors;" M. le Professeur A. Daubrée, "La Géologie Synthétique;" Mr. J. E. H. Gordon gave an explanation of his Anemometer; Mr. C. O. F. Cator "On Anemometers;" Prof. von Oettingen gave a description of his Anemometer; Dr. R. J. Mann, "Lowne's Series of Anemometers;" Mr. John Evans, F.R.S., "Dalton's Percolation Gauge."

This Section meets again to-day and to-morrow, for which days the following programme has been drawn up:—For to-day.—Capt. Baron Ferdinand von Wrangell, "On Self-registering Tide-gauges;" Lieut. Cameron, R.N., "Physical Geography of South Tropical Africa;" Major Anderson, R.E., "Maps of Palestine;" Col. Walker, R.E., or Col. Montgomerie, R.E., "Discoveries in Tibet;" Mr. Francis Galton, F.R.S., "On Means of Combining Various Data in Maps and Diagrams;" Capt. Evans, R.N., C.B., F.R.S., Hydrographer of the Navy, "Hydrography, its present Aspects;" Capt. J. E. Davis, R.N., "The various forms of Sounding Apparatus used by Her Majesty's Ships in ascertaining the depth of the ocean, and the nature of its bottom;" Staff-Commander F. W. Creak, R.N., "Nautical Magnetic Surveys;" Prof. Roscoe, F.R.S., "Automatic Light Registering Apparatus." For to-morrow.—Prof. Ramsay, F.R.S., "The Origin and Progress of the Geological Survey of the British Isles, and the method on which it is conducted;" Mr. W. Topley, F.G.S., "The Sub-Wealden Boring;" Mr. C. E. de Rance, F.G.S., "Sketch of the Geology of the known Arctic Regions;" Mr. W. Galloway, "Colliery Explosions;" Prof. Baron von Ettingshausen, "The Tertiary Origin of the actual Flora;" Mr. J. S. Gardner, F.G.S., "The Tertiary Floras;" M. des Cloiseaux, Membre de l'Institut, "L'emploi des propriétés biréfringentes à la détermination des cristaux;" Mr. Walter Rowley, F.G.S., "Description of his Transit Theodolite for Mine Surveying, and other purposes;" The Rev. Nicholas Brady, M.A., "Desirability of a Uniform International Notation for Crystallography."

This will conclude these Conferences, which are admitted on all hands to have been a great success and to have added very much to the practical value of the collection. The popular expositions we referred to last week have been carried on with success, and apparatus may now be minutely inspected on Wednesdays, Thursdays, and Fridays, on application to the Director of the South Kensington Museum on forms provided for the purpose.

As we intimated last week, the Science and Art Department are organising a series of popular lectures in connection with the Loan Collection, to be given on the evenings of the free days—Mondays, Tuesdays, and Saturdays. We believe that the first of these lectures will be given on Saturday by Prof. Roscoe, F.R.S., on Dalton's Apparatus, and what he did with it."

THE CRUISE OF THE "CHALLENGER"

HER Majesty's ship *Challenger* was despatched towards the close of the year 1872, round the world, on a surveying and discovery expedition of a very special character. Her principal object as laid down in her instructions was to determine, as far as possible, the physical and biological conditions of the great ocean basins, the Atlantic, the Southern Sea, and the Pacific. The voyage was undertaken, as we have already said in our short biographical sketch of Prof. Wyville Thomson, chiefly in consequence of remarkable discoveries made during the four previous years, in short cruises, in H.M. gunboats *Lightning* and *Porcupine*, liberally detached by the Admiralty, at the instance of the Royal Society, for scientific research, under the direction of Dr. Carpenter, C.B., F.R.S., Mr. Gwyn Jeffreys, F.R.S., and Prof. Wyville Thomson, F.R.S. These discoveries seemed so important, not merely in a purely scientific point of view, but also in their bearings on ocean-telegraphy, that the Government determined to follow them up by a deep-sea survey on a more extended scale.

The *Challenger* was fitted out under the superintendence of Admiral Richards, C.B., F.R.S., at that time Hydrographer to the Navy, and in addition to a full naval surveying staff under the immediate superintendence of Capt. Nares, F.R.S., who was afterwards recalled to take command of the Arctic Expedition, a civilian staff of specialists in Natural Science and Chemistry was attached under the direction of Prof. Wyville Thomson.

The expedition, although by no means sensational, has been thoroughly successful. The *Challenger* has steadily traversed a track of 69,000 miles, and during her absence of three years and a half from England has established 362 observing stations, at all of which the depth has been ascertained with the greatest possible accuracy, and at nearly all the bottom temperature has been taken, a sample of the bottom water has been brought up for physical examination and chemical analysis, a sufficient specimen of the bottom has been procured, and the trawl or dredge has been lowered to ascertain the nature of the fauna. At most of these stations serial soundings have been taken with specially devised instruments to ascertain by the determinations of intermediate temperatures and by the analysis and physical examination of samples of water from intermediate depths, the directions and rate of movement of deep-sea currents.

The original arrangements for the cruise have worked in every way smoothly; the weather throughout has been on the whole favourable; under the careful management of Staff-Commander Tizard not a shadow of mishap has ever befallen the ship; there has been a perfect *bon accord* between the naval men and the civilians; all the appliances for carrying on the different operations, liberally supplied at first, were renewed by the officers of the Hydrographic Department of the Admiralty with the utmost liberality and precision.

Two events only have seriously affected the interests of the expedition, one, the sad death at sea of Dr. v. Willemoes-Suhm, one of the ablest of the naturalists on the civilian staff, the other the recall of Capt. Nares; for although Capt. Frank T. Thomson, who joined the *Challenger* from the *Modeste*, did everything in his power to fill his place, Capt. Nares, from his previous scientific training was so eminently fitted to lead such an expedition that his withdrawal in the middle of it was severely felt.

Leaving England on Saturday the 21st of December, 1872, some rough weather was encountered as the *Challenger* stood for the mouth of the Channel, and crossed the Bay of Biscay.

1873

On the 3rd of January, 1873, passing Cape Roca and the lovely heights of Cintra, she was quietly steaming up the Tagus, and came to anchor off Lisbon. Lisbon was left on the 12th. and a series of dredgings and examinations of bottom temperatures were made off Cape St. Vincent in from 400 to 1,200 fathoms. Gibraltar was reached on the 18th, and left on the 26th. The weather was now pretty moderate, and there was a very fairly successful week's sounding, trawling, dredging, and taking temperatures between the Rock and Madeira, which latter station was reached on the 3rd of February. Some of the dredgings made at this period appear to have been most successful, and a number of strange new forms of animal life were found, among these a fine new species of Venus's Flower-basket (*Euplectella suberea*), Fig. 1, a Bryozoon (*Naresia cyathus*), (see figure, vol. vii. p. 387) of singular beauty, which was dedicated to Capt. Nares, some wondrous forms of Sea-Urchins and Lily-Stars, and specimens of a species of "Clustered Sea-polype," since described by Dr. Kolliker under the name of *Umbellularia thomsoni*, an animal of great scientific interest.

But two days were spent at Madeira, and the *Challenger* was off Teneriffe early on the morning of the 7th, too early to attempt the ascent of the famous Peak, and rather too early for natural history work, still collections, both geological and zoological, were made, a series of dredgings were successfully tried between Teneriffe and Palma, past Gomera and Hierro, and a great number of observations as to temperature were taken. In the matter of meteorological observations we may mention that the officers of the Expedition seem to have excelled; the number of observations amounted during the first twelve months of the cruise to upwards of 50,000. Very considerable depths were found off the Canary Islands, extending sometimes to upwards of 1,700 fathoms; but the greatest depth found in this part of the Atlantic was one of 2,500 fathoms off Cape St. Vincent.

At Teneriffe the regular work of the Expedition may be said to have commenced. All the time between leaving home and arriving off the Canaries had been more or less devoted to getting the varied machinery into order, and in settling the direction and scope of the parts the members of the civilian staff had to play; so at Santa Cruz the old journals were closed, and the numbering of the stations and the other entries were commenced afresh, with some alterations the result of additional experience. A section was now to be carried right across the Atlantic from Teneriffe to Sombrero, the latter a little speck of an island north-west of Anguilla, and one of the group of Virgin Islands, themselves a portion of the West Indies. Sombrero was reached on the 15th of March, just a month from the time of leaving Santa Cruz. The distance between the two islands is about 2,700 miles, and along this line twenty-three stations were selected, at which most careful observations were made as to depth, condition, and temperature of bottom. During one of these dredgings, and at a depth of 1,500 fathoms, several specimens of a magnificent sponge belonging to the Hexactinellidæ were found attached to the branches of an Isis-like coral, and nestling among the fibres of the sponge were star-fishes, annelids, and Polyzoa. Often during this cruise, when the weather was calm and hot, the tow-net was used on the surface. It would seem that the greater number of the pelagic forms retire during the heat of the day to the depth of a few fathoms, and come up in the cool of the evening and in the morning, and in some cases in the night. The larger phosphorescent animals were frequently abundant during the night round the ship and in its wake, while none would be taken during the day One day (the 26th of February), the morning being bright and clear and the swell not heavy, the ship being some 1,600 miles from Sombrero, and in lat. 23° 23′ N., long. 32° 56′ W., the sounding-line indicated a depth of 3,150 fathoms, and the bottom was found to consist of a perfectly smooth red clay, containing scarcely a trace of organic matter. This was the greatest depth as yet met with, and the material from the bottom

was something quite novel to the explorers. At the mean maximum depth of some 2,200 fathoms the ooze was one vast mass of the calcareous shells of foraminifera, but as the soundings got deeper the ooze began to assume a darker tint, and showed, on analysis, a continually decreasing quantity of calcareous matter. Now in this red ooze almost no calcareous forms were to be met with, and it was of extreme fineness, remaining for a long time in suspension in water, and proving on analysis to be almost pure clay, a silicate of alumina and the sesquioxide of

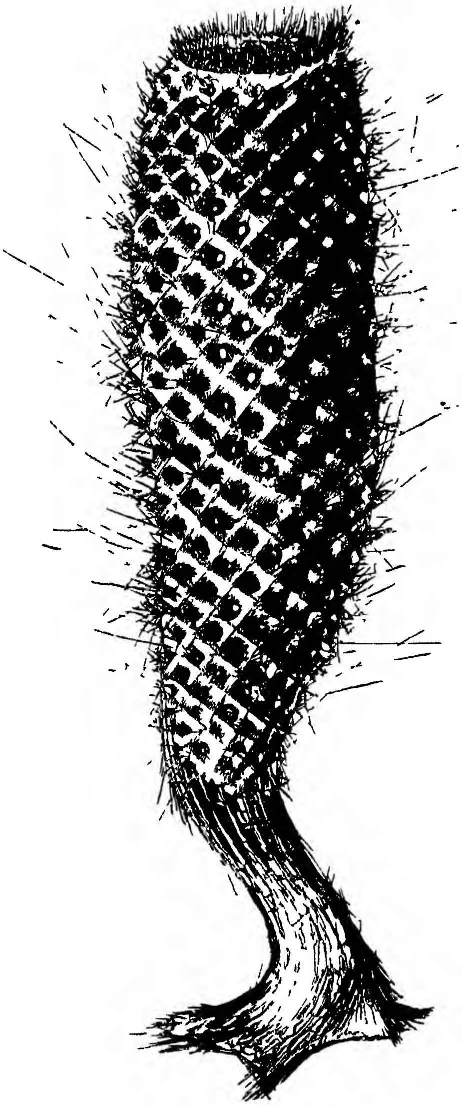


FIG. 1.—*Euplectella suberea.*

iron, with a small quantity of manganese; and at this depth there appeared to be an absence of animal life.

Prof. Wyville Thomson considers it as quite proved that all the materials for such deposits, with the exception of the remains of those animals which are now known to live at the bottom at almost all depths, are derived from the surface; and considering the very enormous extension of the calcareous ooze, it becomes important to know something of the minute foraminifera that produce it. In all seas, from the equator almost to the polar ice, the surface-water contains *Globigerinæ*. They are more abundant and of a larger size in warm seas; several varieties attaining a large size, and presenting marked varietal characters, are found in the intertropical area of the Atlantic. In the latitude of Kerguelen they are less numerous and smaller, while further south they are still more dwarfed, and only one variety, the typical *Globigerina bulloides*, is represented. The living *Globigerinæ* from the tow-net are singularly different in appearance from the dead shells we find at the bottom (Fig. 2). The shell is clear and transparent, and each of the pores which penetrate it is surrounded by a raised crest, the crest round adjacent pores coalescing into a roughly hexagonal network, so that the pore appears to lie at the bottom of a hexagonal pit. At each angle of this hexagon the crest gives off a delicate flexible calcareous spine, which is sometimes four or five times the diameter of the shell in length. The spines radiate symmetrically from the direction of the centre of each chamber of the cell, and the sheaves of long transparent needles, crossing one another in different directions, have a very beautiful effect. The smaller inner chambers of the shell are entirely filled with an orange-yellow granular sarcode; and the large terminal chamber usually contains only a small irregular mass, or two or three small masses run together, of the same yellow sarcode stuck against one side, the remainder of the chamber being empty. No definite arrangement, and no approach to structure, was observed in the sarcode; and no differentiation, with the exception of bright-yellow oil-globules, very much like those found in some of the Radiolarians, which are scattered apparently irregularly in the sarcode, and usually one very definite patch of a clearer appearance than the general mass coloured vividly with a carmine solution. The presence of scattered particles of bioplasm was indicated by minute spots here and there throughout the whole substance which received the dye.

When the living *Globigerina* is examined under very favourable circumstances, that is to say, when it can be at once placed under a tolerably high power of the microscope in fresh still sea-water, the sarcodic contents of the chambers may be seen to exude gradually through the pores of the shell, and spread out until they form a kind of flocculent fringe round the shell, filling up the spaces among the roots of the spines and rising up a little way along their length. This external coating of sarcode is rendered very visible by the oil-globules, which are oval, and filled with intensely-coloured secondary globules, and are drawn along by the sarcode, and may be seen, with a little care, following its spreading or contracting movements. At the same time an infinitely delicate sheath of sarcode containing minute transparent granules, but no oil granules, rises on each of the spines to its extremity, and may be seen creeping up one side and down the other of the spine with the peculiar *flowing* movement with which we are so familiar in the pseudopodia of *Gromia* and of the Radiolarians. If the cell in which the *Globigerina* is floating receive a sudden shock, or if a drop of some irritating fluid be added to the water, the whole mass of sarcode retreats into the shell with great rapidity, drawing the oil-globules along with it, and the outline of the surface of the shell and of the hair-like spines is left as sharp as before the exodus of the sarcode.

There is still a good deal of obscurity about the nature of *Orbulina universa*, an organism which occurs in some places in large proportion in the globigerina ooze. The shell of *Orbulina* (Fig. 3) is spherical, usually about ·5 mm. in diameter, but it is found of all smaller sizes. The texture of the mature shell resembles closely that of *Globigerina*, but it differs in some important particulars. The pores are markedly of two different sizes, the larger about four times the area of the smaller. The larger pores are the less numerous; they are scattered over the surface of the shell without any appearance of regularity; the smaller pores occupy the spaces between the larger. The

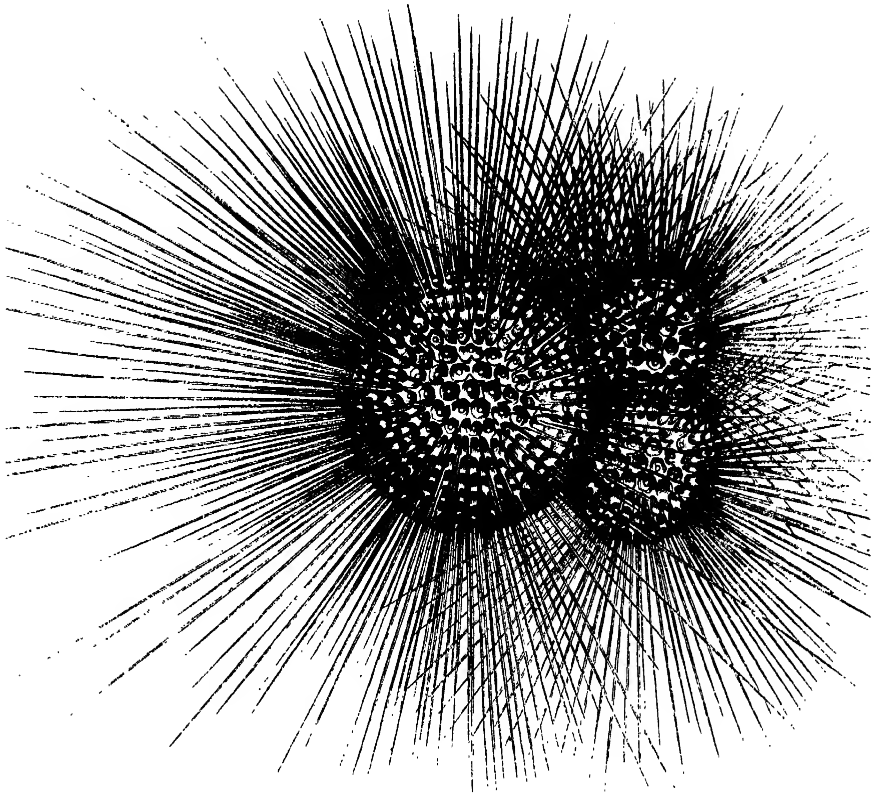


FIG. 2.—*Globigerina.*

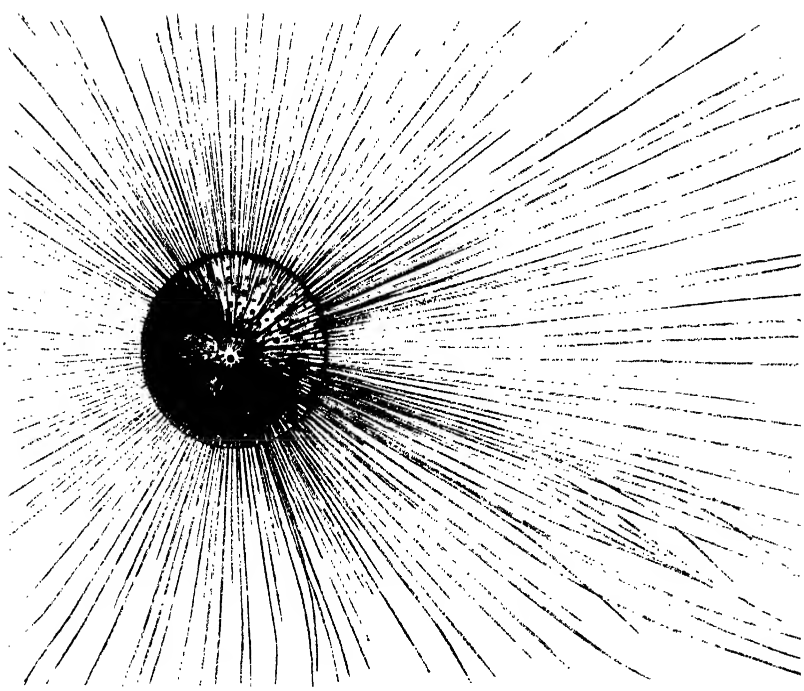


FIG. 3.—*Orbulina.*

crests between the pores are much less regular in *Orbulina* than they are in *Globigerina;* and the spines, which are of great length and extreme tenuity, seem rather to arise abruptly from the top of scattered papillæ than to mark the intersections of the crests. This origin of the spines from the papillæ can be well seen with a moderate power on the periphery of the sphere. The spines are hollow and flexible; they naturally radiate regularly from the direction of the centre of the sphere; but in specimens which have been placed under the microscope with the greatest care, they are usually entangled together in twisted bundles. They are so fragile that the weight of the shell itself, rolling about with the motion of the ship, is usually sufficient to break off the whole of the spines and leave only the papillæ projecting from the surface in the course of a few minutes. In some examples, either those in process of development, or a series showing a varietal divergence from the ordinary type, the shell is very thin and almost perfectly smooth, with neither papillæ nor spines, nor any visible structure except the two classes of pores, which are constant.

The Coccospheres and Rhabdospheres—these are suggested to be minute algæ forms—live on the surface, and sink to the bottom after death. Many of them are extremely beautiful, as will be seen from Figs. 4 and 5, representing two forms first discovered by Mr. Murray.

Taking the section from Teneriffe to Sombrero, first of all some 80 miles of volcanic mud and sand were passed; then some 350 miles of globigerina ooze; next about 1,050 miles of red clay; then again a rising ground for some 330 miles of globigerina ooze, a valley of 850 of red clay; and nearing land some 40 miles of the globigerina ooze. Intermediate between the red clay and the globigerina ooze, a grey ooze was met with, partaking of the characters of both, and evidently a transitional stage. "There seems to be no room," writes Prof. Wyville Thomson, "left for doubt that the red clay is essentially the insoluble residue, the *ash*, as it were, of the calcareous organisms which form the 'globigerina ooze,' after the calcareous matter has been by some means removed. An ordinary mixture of calcareous Foraminifera with the shells of Pteropods, forming a fair sample of 'globigerina ooze' from near St.

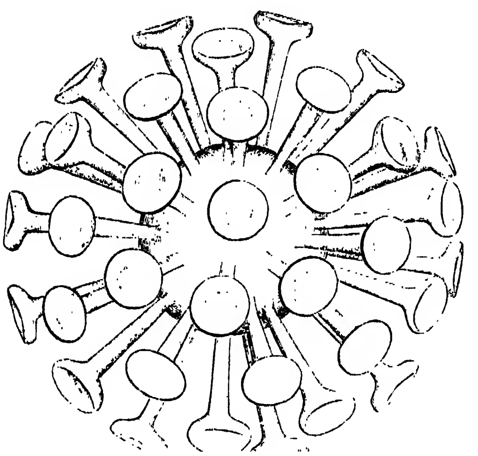
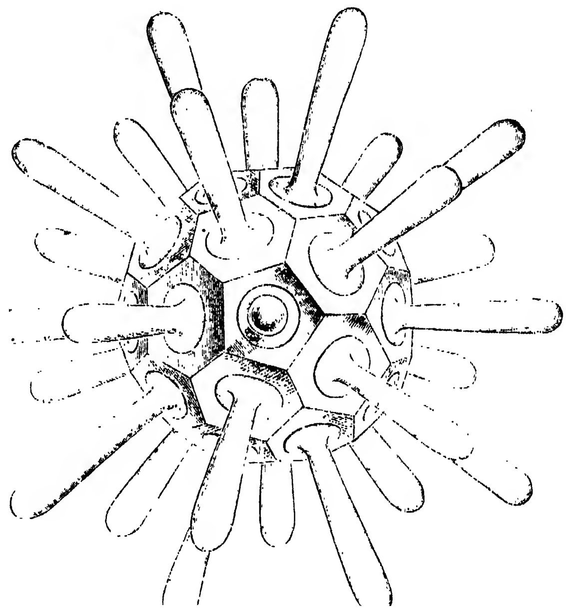


Fig. 4.—Rhabdosphere.



Thomas, was carefully washed and subjected by Mr. Buchanan to the action of weak acid; and he found that there remained, after the carbonate of lime had been removed, about one per cent. of a reddish mud, consisting of silica, alumina, and the red oxide of iron. This experiment has been frequently repeated with different samples of 'globigerina ooze,' and always with the result that a small proportion of a red sediment remains, which possesses all the characters of the 'red clay.' I do not for a moment contend that the material of the 'red clay' exists in the form of the silicate of alumina and the peroxide of iron in the shells of living Foraminifera and Pteropods, or in the hard parts of animals of other classes. That certain inorganic salts other than the salts of lime exist in all animal tissues, soft and hard in a certain proportion, is undoubted; and I hazard the speculation that during the decomposition of these tissues in contact with sea-water and the sundry matters which it holds in solution and suspension, these salts may pass into the more stable compound of which the 'red clay' is composed."

On this voyage Mr. Buchanan found the remarkable and unexpected result that the water has virtually the same specific gravity from the bottom to within 500 fathoms of the surface. From 500 fathoms the specific gravity rapidly rises till it usually attains its maximum at the surface. Nineteen dredgings were taken, and these yielded a large supply of animal forms. It is unfortunate that in the deepest haul of all, 3,150 fathoms, no living thing was brought up higher in the scale than a foraminifer; but this may be attributed to the nature of the bottom, an opinion borne out by the abundance, at scarcely a less depth, and on a bottom differing only in being somewhat less uniform, and containing sand-grains and a few shells of foraminifera, of tube building annelids of a very common shallow water type. The crustacea do not appear to suffer from the peculiarity of the circumstances under which they live, either in development or in colour. The singular fact of the suppression of the eyes in certain cases is already well known. The Echinoderms and sponges which enter so largely into the fauna of the zone ending at 1,000 fathoms are not abundant at extreme depths.

The *Challenger* next anchored off the harbour of Char-

lotte Amalia, at St. Thomas, where a pleasant week was spent, and on the 25th of March she proceeded on her way to the Bermudas. On Monday the 26th, being then in lat. 19° 41′ N., long. 65° 7′ W., and nearly ninety miles north of St. Thomas, a sounding was made in the great depth of 3,950 fathoms, and a dredge was let down to see if it would prove serviceable; heaving-in commenced at 1.30, and the dredge came up at 5 P.M. with a considerable quantity of reddish-grey ooze. No animals were detected except a few small foraminifera with calcareous tests, and some considerably larger of the arenaceous type.

On the 4th of April she made her way through the intricate and dangerous "narrows" between the coral reefs, and by the evening was at anchor at Grassy Bay, Bermudas. A fortnight was spent at these Islands. Their geological structure was most carefully studied, and when the narrative of the cruise is published we may expect very valuable information as to the formation of the various forms of limestone to be found on these islands. The principal islands are well wooded, but the great preponderance of the Bermudian Cedar (*Juniperus bermudiana*) gives a gloomy character to the woods, which in the annexed woodcut is somewhat relieved by the presence of some palm trees (Fig. 6). The Admiral's official residence, Clarence Hill, is situated on an inclosed little bay called Clarence Cove. The garden was rich with a luxuriant tropical vegetation of which the group of papau trees, *Carica papaya* (Fig. 7), will give some idea.

There is only one kind of rock in Bermudas. The islands consist from end to end of a white granular limestone, here and there becoming grey or slightly pink, usually soft and in some places friable, so that it can be broken down with the ferrule of an umbrella; but in some places, as on the shore at Hungry Bay, at Painter's Vale, and along the ridge between Harrington Sound and Castle Harbour, it is very hard and compact, almost crys-

FIG. 6.—Swamp Vegetation, Bermudas.

talline, and capable of taking a fair polish. This hard limestone is called on the islands the "base rock," and is supposed to be older than the softer varieties and to lie under them, which is certainly not always the case. It makes an excellent building stone, and is quarried in various places by the engineers for military works (Fig. 8). The softer limestones are more frequently used for ordinary buildings. The stone is cut out of the quarry in rectangular blocks by means of a peculiarly constructed saw, and the blocks, at first soft, harden rapidly, like some of the white limestones of the Paris basin, on being exposed to the air.

Immense masses of fine coral sand surround the shores, being washed in by the sea. It is then caught at certain exposed points by the prevailing winds, and blown into sand-hills often forty to fifty feet in height. Sometimes these sand-masses form regular sand-glaciers. One of these was found at Elbow Bay on the southern shore of the main island. The sand has entirely filled up a valley and is steadily progressing inland in a stream some five and twenty feet. It has, as will be seen in the woodcut (Fig. 9), partially overwhelmed a garden, and is still flowing slowly on. When the photograph from which the woodcut is copied was being taken, the owner of the garden was standing with his hands in his pockets, as is too much the habit of his race, contemplating the approach of the inexorable intruder. He had, as will be seen, made some attempt to stay its progress, by planting a line of oleanders and small cedars along the top of the slope, but this had been in vain.

The botanists of the expedition paid a good deal of attention to the flora of the island, and we may expect a lot of new forms among the minute algæ found in the so-called freshwater ponds or lakes.

Bermudas was left on the 20th of April, and a section was carried out from the islands towards Sandy Hook,

and then south and west of Little George Bank and into Halifax on the 9th of May. In this run several soundings were taken at depths of from 2,600 to 2,800 fathoms. The bottom yielded chiefly grey ooze, and the course of the Gulf Stream was crossed. Staying a week at Halifax to recruit, the next section was made in almost a straight line from Halifax to Bermudas, which was reached on the 30th of May, nine important stations having been selected and examined on the way. A short time was passed at Bermudas, and the next section it was determined to make was one between lat. 35° and 40° to the Azores. Leaving Bermudas on the 12th of June the *Challenger* was off Fayal on the 1st of July, having successfully made observations at seventeen stations *en route*. A small-pox epidemic having broken out at Fayal, it was not deemed prudent to land. San Miguel was visited, and the straits between it and Santa Maria were explored, and the *Challenger* on the 10th stood for Fauchal, reaching it on the 15th, having been now more than a month at sea. Having made two sections right across the Atlantic, all looked to enjoying a few days on land, but it was not to be so, for most unluckily a rather severe epidemic of small-pox had broken out at Madeira also shortly before, and Capt. Nares did not think it prudent to give

FIG. 7.—*Canna*

leave; accordingly on the 18th of July they commenced to make a section along the West Coast of Africa. It was the rainy season; each day would bring them nearer to the equator, and it was scarcely possible to look forward to other than disagreeable times. On the 19th they were off Palma Island, one of the Canaries; then they bore down on S. Antonio, one of the Cape Verd islands, and were at St. Vincent on the 27th of July.

The botany of this island, so noted in the old gazetteers for its wood, water, wild goats, turtles, and saltpetre, was carefully explored. As seen from the sea, the rocks presented a singular appearance, owing to the presence of a thick incrustation at water-mark of masses of calcareous algæ, which either follow the forms of the rocks or occur in rounded masses, their delicate tints of white, light pink, or cream colour considerably heightening the effect. These incrustations are frequently bored by *Lithodomus caudigerus* and other molluscs, and small sponges and Polyzoa occupy the cavities between them and the rocks.

Leaving the Cape Verd Islands, on the 13th of August they were off the Bissagos Islands, and found bottom at a depth of 2,575 fathoms. Continuing to cruise along the coast, on the 14th they were west of the Loss Islands; on the 15th they passed Sierra Leone; on the 19th they

were off Cape Mesurado, still in depths of 2,500 fathoms and on the 21st they had run as far along the Western Coast of Africa as they intended, being then off Cape Palmas, and the *Challenger's* course was shaped for St Paul's Rocks These rocks lie about 1 north of the equator, and in longitude 29 15' W, being about mid way between the South American and African coasts Although rising to a height of some 50 to 60 feet above the sea level, yet they are mere rocks, not more than a quarter of a mile long The sea deepens quickly in the vicinity of the rocks to depths of from 1,500 to 2,200 fathoms The wash of the waves is such that even sea weeds cannot retain their positions on the rocks

Proceeding still in a south west direction, the little group of islands called Fernando Noronha was reached on the 1st of September, and some days were spent exploring it The group consists of a principal island about four miles long by three and a half broad, and several smaller ones, it is situated in the Atlantic, in about lat 3° 56 S, long 32° 22 W, and about 200 miles from the nearest point of the American coast The islands appear to be of volcanic origin the peak on the northern side of the principal island rises to a height of 1,000 feet, it is a mass of bare rock the summit of which is quite inaccessible The cliffs are chiefly composed of columnar basalt The sea depth in the neighbourhood is from 1,000 to 2,000 fathoms Trees abound on the higher parts of the island, and wondrous creepers cluster together in the branches of the trees A species of Cereus was found by Mr Mosely on the cliffs Only one grass (*Oplismenus colonus*) was found on the main island, but although shady, moist places occur about St Michael's Mount, neither on this nor on the main island were any ferns, mosses, or hepaticæ found, and lichens were very scarce Among the principal cultivated fruits are bananas and melons, the latter being very plentiful, and of

Fig 8 —Blown sand Rocks, Bermudas

peculiarly fine flavour Sugar cane, cassava, maize, sweet potatoes, were grown in large quantities The species of land animals on the island are not numerous, but individuals of several of them are most abundant, two species of lizards are recorded from the islands, one being peculiar to the group

On the 4th of September the *Challenger* was some 90 miles south of Cape St Roque, in 2,275 fathoms, with globigerina ooze. On the 8th she was off Parahyba, in 2,050 fathoms, with mud On the 9th the sounding gave a depth of only 500 fathoms off Cape San Agostinho The depth increased off Macayo (September 11) to 1,715 fathoms, diminishing off the mouth of the River San Francisco to 1,200 fathoms, and as the coast at this spot was approached to 700 fathoms On the 14th the *Challenger* was at Bahia, and stopping there a short time she proceeded for a section across the Atlantic from Bahia to the Cape of Good Hope Owing to unfavourable winds and other causes, the little Island of Trinidad an island whose vegetation was then totally unknown, had to be passed by, and the ship's course was directed to the little known islands of Tristan d Acunha, and on the 18th of October she was anchored on the north side of the large island which gives its name to the group This island rises in a range of almost perpendicular cliffs of black volcanic rock, in appearance somewhat similar to that exposed in section on the Grande Curral, in Madeira At their base are *debris* slopes, and a narrow strip of low shore land, on a portion of which lies the settlement Unfortunately, before much even of these slopes could be explored by the landing party, a sudden squall came on the recall was hoisted from the ship, and they had to leave after a visit of only six hours Grasses, sedges, mosses, and ferns were found growing on the cliffs and hepaticæ so abounded as to cover the earth with quite a green sheet, occasional patches of *Phylica arborea* were

seen. This tree, belonging to the family Rhamnaceæ, is peculiar to these islands and to Amsterdam Island, in the South Indian Ocean. *Lomaria alpina*, when found in stony places, bore fertile fronds, while those growing in rich vegetable mould were barren. Some of our common weeds were finding themselves at home, such as the sow-thistle. That lovely little cinchonaceous plant, *Nertera depressa*, was very abundant. Growing round the island was a belt of that gigantic sea-weed, *Macrocystis pyrifera*, which abounds in the southern temperate zone. Single plants often grow to a length of 200 feet, and it is said that they sometimes are met with from 700 to 1,000 feet in length, forming cable-like masses nearly as thick as a man's body. There was no time to explore the high plateau; but one interesting observation was made, indicating the presence of snow on the hills, for while the temperature of the fresh-water ponds at the sea-level gave a result of 54° F., that of the streams running down the cliffs was but 50° F.

They had an opportunity of visiting the two other islands of this group, Inaccessible Island, about twenty-three miles W. by S. of Tristan d'Acunha, and Nightingale Island, about twelve miles from Inaccessible Island. On this latter two Germans were found, who had succeeded in cultivating the ground in the neighbourhood of their dwelling. On both islands *Phylica arborea* was found, and the trees were covered with fully-developed green fruits. A tussock grass, apparently very close to *Dactylis cæspitosa*, of the Falklands, grew in immense, almost impenetrable masses on Nightingale Island, amid these countless penguins had established themselves. It was but with the greatest difficulty that a passage could be forced through such thicket, the grass being too high to allow of the planning of any definite track, and the screaming and biting of the penguins was the reverse of agreeable. This island is never visited except during the sealing season, and is not over one square mile in extent, a veritable speck in the ocean.

The ship's head was now turned for Simon's Bay. Five stations between these points were selected for observation. The depth varied on this line from 2,100 to 2,650 fathoms, the bottom yielding red mud at the greater, and grey mud at the lesser depths. The 28th of October saw the *Challenger* at anchor off Capetown.

Simon's Bay was left about the 14th of December, six weeks having been spent in recruiting and refitting. Even

FIG. 9—Sand glacier, Bermudas

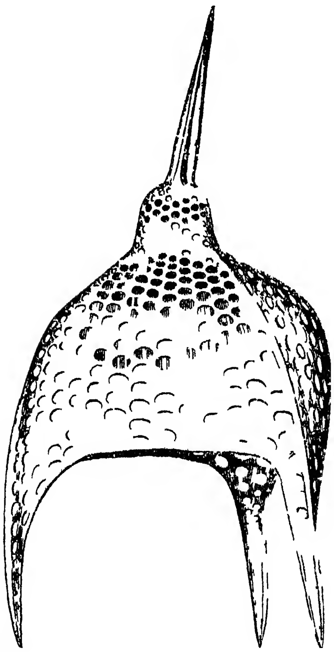
in the comparatively well-worked-out district of Capetown new discoveries were made, of which by far the most important was Mr. Moseley's discovery of the tracheal system in *Peripatus capensis*, an account of which has been published in a late volume of the *Philosophical Transactions*. This tracheal system, though conspicuous in the fresh condition, becomes scarcely visible when the animal has been some time in spirit, and the air has been thus removed, hence the failure of Grube, Saenger, and others to see it. The first soundings during the southern course were taken in the region of the Agulhas Current on the 17th and 18th of December. These soundings would have been naturally logged "greenish sand," but on examination were found to consist almost without exception of the casts of foraminifera in one of the complex silicates of alumina, iron and potash, probably some form of glauconite; this kind of bottom had been met with once or twice, but is evidently quite exceptional. Going still south, Marion Island was visited for a few hours and a considerable collection of plants, including nine flowering species, was made. Dredging near the island gave a large number of species, many representing northern types, but with a mixture of southern forms. On the 30th of December, being then between Prince Edward's Island and the Crozets, the dredge was let down to a depth of 1,600 fathoms, and a vast number of species belonging to the well-known genera *Euplectella*, *Hyalonema*, *Umbellularia*, *Pourtalesia*, as well as two new genera of stalked crinoids, several quite new spatangoids, and several remarkable crustacea were taken.

1874

The new year opened with a storm, and they could not land on Possession Island, on account of the weather; though a dredging in 210 and another in 550 fathoms about eighteen miles to S.W. of the island were made with satisfactory results. On the 7th of January Kerguelen's Island was reached, and the *Challenger* remained there till the 1st of February. During that time Dr. v. Willemoes-Suhm was chiefly occupied in working out the land fauna, Mr. Moseley collected the plants, Mr. Buchanan attended to the geological features, while Prof. Wyville Thomson and Mr. Murray dredged in the shallow waters round the islands with the steam-pinnace. Many observations were made, some on the development of the Echinoderms, and great collections were stored away. On one occasion the trawl

net came up nearly filled with some large cup sponges, probably belonging to the same species as was dredged up by Sir James Clarke Ross many years ago near the Ice barrier On the 2nd of February they were 140 miles south of Kerguelen, and on the 6th they reached Corinthian Bay in Young Island, and had made all arrangements for examining it when a sudden change of weather obliged them to put to sea, though one or two of the party had succeeded in spending an hour or two on shore The most southerly station made was on the 14th of February in lat 65 42 S, long 79° 49 E, when the trawl brought up from a depth of 1 675 fathoms a considerable number of animals Dredging so near the Antarctic circle was, however, not only a severe but a somewhat critical operation the temperature of the work rooms for days averaged seven or eight degrees below freezing point, the ship was surrounded by icebergs, and snow storms from the south east were constantly blowing against her

On the 23rd of February the wind had risen to a whole gale, the thermometer fell to 1 1 the snow drove in a dry blinding cloud of exquisite star like crystals which burned the skin as if they had been red hot and none were sorry to turn northwards This was a period of sore anxiety to all in charge still observations on temperature were carried on the specific gravity of the water was taken daily by Mr Buchanan and soundings and observations were also made on ... The soundings and dredgings while they were among the ice ... to 1 975 fathoms, gave evidence of a very distinct deposit of yellowish clay with pebbles and small stones, and a considerable admixture of Diatoms Radiolarian &c, the former doubtless being a deposit from the melting icebergs Soundings were made on the ... of February, and 3rd and 7th of March in 1 800 fathoms when some very remarkable large sized star fishes were met with On the 13th of March, at a depth of 2 ... fathoms, with a bottom temperature of 0 ... C Holothurians were abundant, as well as many other animal forms



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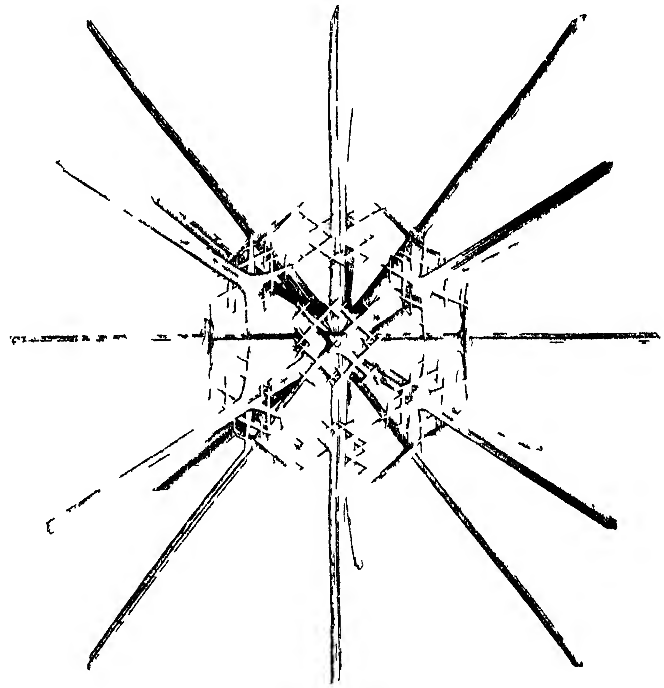

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Melbourne was reached on the 17th of March and some weeks were pleasantly spent, which were all the more refreshing after the hardships of the tour to the Antarctic circle Next Sydney was visited, and here everything was done by the inhabitants to welcome the members of the Expedition that could be done, and there is no doubt that the memory of their visits to our Australian Possessions will linger among the pleasant ones that they will indulge in for years A very careful survey of that portion of the Pacific Ocean that intervenes between the coasts of Australia and New Zealand was required for electric telegraph purposes, and the soundings made by the *Challenger* gave every reason to expect that it would not be ... ere New Zealand would be in telegraphic connection with Europe as indeed it now is. Until the end of June the *Challenger* was engaged on this work but on the 6th of July, 1874 she set out once more on an ocean cruise

Leaving Wellington on the 7th she proceeded under sail along the east coast of New Zealand On the 10th they were about forty miles to the east of East Cape, and continuing their course towards the Kermadec Islands, on the 14th they were off Raoul Island. The specimens brought up from a depth of 6 .. fathoms were just such as one would have expected to find in a similar depth off the coast of Portugal On the evening of the 19th they arrived at Tongatabu one of the Friendly Islands Two days were spent in visiting different parts of the island, and a few hauls of the dredge were made in shallow water off the coast They next made a straight course for Matuku Island the most southerly of the Fijis, where, on the 24th, a party of surveyors and naturalists landed, some others explored the sea along the coast, trawling in some 1 to 3.. fathoms and procuring among other fine things a specimen of the Pearly Nautilus *Nautilus pompilius* which was kept alive in a tub of salt water for some time so as to watch its movements Kandavu was reached on the 25th Levuka was visited on the 28th, and the ship returned to Kandavu on the 3rd of August, to remain for a week The natural history of the coral reefs surrounding the Fijis was examined by the civilian staff, who received every assistance possible from Mr Layard, H M Consul Between New Zealand and the Fiji group only two soundings had been taken to a greater depth than 1 000 fathoms, one off Cape Turnagain, New

Zealand, gave a bottom of grey ooze at 1,100 fathoms, and the other, midway between the Kermadecs and Friendly Islands, gave red clay at a bottom of 2,900 fathoms, the other dredgings and soundings were in depths of from 3 to 600 fathoms, and many of the former yielded an abundance of animal life.

On the 10th of August the *Challenger* left for Api, one of the least known of the New Hebrides, and on the 18th anchored off the island Capt Nares had given a passage from Fiji to eleven men of Api, and two or three of the officers, with an armed party of marines, took the returned labourers on shore. The natives appeared somewhat mistrustful, and were armed with clubs, spears, and bows with sheaves of poisoned arrows, so that it was not thought prudent to go into the forest. The natives were almost entirely naked, and were of rather a savage and forbidding aspect From Api the *Challenger's* course was to the north-westward, towards Raine Island, which is in a breach of the great barrier reef not far from the entrance to Torres Straits A sounding on the 19th, in lat 16 47 S, long 165 20′ E., at a depth of 2,650 fathoms, with a bottom of red clay, give a bottom temperature of 1 7 C (35 1) A serial temperature sounding was taken to the depth of 1,500 fathoms, and it was found that the minimum temperature (1 7 C) was reached at a depth of 1,300, and that consequently a stratum of water at that uniform temperature extended from that depth to the bottom

Serial temperatures were taken on the 21st 24th, 25th, 27th, and 28th of August, in 2,325, 2,450, 2 440, 2,275, and 1,700 fathoms respectively, and in each case the minimum temperature of 1 7 C. extended in a uniform layer, averaging 7,000 feet in thickness, from the depth of 1,300 fathoms to the bottom. The area over which this temperature existed has been called the "Melanesian Sea," and it is evident that there is no free communication between it and the outer ocean to a greater depth than 1,300 fathoms, the encircling barrier being complete up to that point. The animals procured in this sea were few in number, but sufficient to show that the existence of a fauna is not impossible in the still bottom water of such an inclosed area, though, as in the Mediterranean, such conditions do not appear to favour life

On the 31st Raine's Island was visited, and found to be just as described by Jukes, a collection of the birds breeding there was made, and the next day, the 1st of September, the ship was at Cape York Proceeding thence across the Arafura Sea to the Aru Islands, Dobbo, a town on the Island of Wamma, was reached on the 16th After a few days spent in shooting some birds of Paradise and getting an idea of the natural history of the place, they proceeded to Ke Doulan, the principal village in the Ké group, thence to the Island of Banda, where they remained a few days, and thence to Amboina, which was reached on the 4th of October In some of the dredgings between Ke and Amboina a wonderful assemblage of forms were met with, not only new Pentacrinoid forms, but many new vitreous sponges—Echinoderms, Crustacea, &c. From Amboina they went to Ternate, and thence across the Molucca Passage into the Celebes Sea, by the passage between Bejaren Island and the north east point of Celebes Crossing the Celebes Sea, Zamboanga was reached on the 23rd, and the Sulu Sea on the 26th. Capt Chimmo's observations on this basin-sea were confirmed. Ilo Ilo was visited on the 28th, and proceeding by the eastern passage round Mindoro, Manila was made on the 4th of November, and after a short stay at the Philippines, Hong Kong was made head quarters for a time During the *Challenger's* stay here Capt Nares received a telegram offering him the command of the Arctic Expedition This was a great blow to all of the party. Though sorry to part with one who had so far brought the expedition successfully on its way, the importance was fully recognised of having a man of his character and experience in command of the North Pole Expedition. Capt Thomson, who was already on the China Station in command of the *Modeste*, took Capt. Nares's place.

1875

Hong Kong was left on the 6th of January, with the intention of sailing to the region of the Equator, then making a series of stations parallel to it, for a distance of some 2 000 miles, and eventually going north to Japan Proceeding to the middle of the China Sea, a series of temperature soundings were taken, the temperature at the bottom of 1,200 fathoms being 36 I This is accounted for by Chimmo's statement that the China Sea is cut off, by a barrier rising to a height of 800 to 900 fathoms below the surface of the water, from communication with the waters of the Antarctic Ocean Passing along the west coast of Luzon, the *Challenger* entered the Panay Sea, where further observations were made, visiting Zebu, the first known locality for the 'Venus Flower basket,' where some fine specimens of this sponge were obtained in the dredge Next the ship made for the little island of Camaguin—between Mindanao and Bohol to inspect the active volcano there on This volcano was ushered into existence on the 1st of May, 1871, and presented at the time of the *Challenger's* visit the appearance of an irregular cone of 1 950 feet in height, its base was gradually extending, and had covered the town of Catarman From Camiguin the *Challenger* went along the west coast of Mindanao to Zamboanga, which was (for the second time) reached in the last week of January (29th A little party of sportsmen were sent off to camp out in the forest within riding distance of the ship, visits were paid to them from time to time, and they thoroughly enjoyed their brief sojourn in the heart of a most exquisite little bit of tropical scenery, and surrounded by multitudes of monkeys, galeopitheci, and many more of the strange denizens of such woods Thus was a pleasant week spent, and with some regrets Zamboanga was left on the 8th of February The following day was spent in the strait between Mindanao and Basilan The view of both islands from the strait was extremely beautiful from the luxuriance of the vegetation which filled up the gullies and mantled over every basalt ridge and peak up to their very summits On the 9th the party were off Cape San Augustin and in view of Balut, the finest of the Sarangani Islands, with a fine volcanic cone thickly wooded to the top On the 10th they had a very successful haul of the dredge off the Island of Tulur, in 500 fathoms, getting many specimens of three or four species of Pentacrinus, with stems two or three feet high About this time the wind felt very light and uncertain, and a strong current was setting them down towards the coast of New Guinea The coal supply was running short, and was required for dredging and sounding up to Japan, the nearest place for a fresh supply, so Capt Thomson determined to make for Humboldt Bay On the 21st of February, still drifting southwards, they were opposite the delta of the great river Amberno, which rises in the Charles Louis Mountains, a splendid range in the interior of New Guinea, upwards of 16,000 feet high, and falls into the sea at Cape D'Urville, to the east of the entrance of Geelvink Bay Night was falling on the 23rd as the *Challenger* cast anchor just within the headlands of Point Caille and Point Bonpland Next morning, shortly after daybreak, the ship was surrounded by about eighty canoes, each from 15 feet to 20 feet long and with crews of from four to six men each There were no women or children among them. The men were unusually good looking for Melanesians, and wonderfully picturesque, they seemed on an average about 5 ft. 4 in. in height, features tolerably good, nose rather thick and flat, eyes dark and good, expression agreeable, mouth large, and lips rather full, betel and chinam chewing had destroyed their teeth and dyed their gums crimson, and their ear lobes were greatly lengthened by earrings Their

hair is frizzled, not woolly, very thick, and worn in the shape of a huge round mop; it was partly bleached by lime, or coloured red by lime and ochre; black and white feathers and coronals of scarlet Hibiscus flowers were worn on their heads; the face was smeared with black or red pigment; with the exception of a few ornaments the body was entirely naked; the skin dark brown in the shade, warmed to a rich red brown in the sunlight. A band of tappa, variously ornamented, encircled the middle of the upper arm on both sides, and into this they stuck, towards the outside of the arm, large bunches of the fresh green and white leaves of a beautiful narrow-leaved Croton. The natives were well armed with strong bows and arrows, the latter five to six feet long, with heads bristling with barbs. In almost every canoe there were stone hatchets mounted on hard wood handles, closely resembling those found in Denmark; they were made of a hard, close-grained green stone, taking a jade-like polish. The canoes had generally a grotesquely carved prow, the paddles being of hard wood, leaf-shaped, and often prettily carved.

In the course of the afternoon Capt. Thomson and Prof. Wyville Thomson went in the galley to an island where there was a village, to ascertain the temper of the natives and see if it were safe to go about freely. They were rowed to a sandy beach and made signs that they wished to land, but the whole population, consisting chiefly of women and boys, all armed with bows, turned out with the most determined demonstrations of hostility. The women were not prepossessing; the young girls were perfectly naked, and were no ornaments; the matrons wore a fringe of rough bark cloth round their loins. The village consisted of some twenty to thirty huts, some on land under the trees, but most of them built on a platform raised a few feet above the surface of the sea on piles and communicated with the shore by planks removed at pleasure. Another boat sent off to get sights had been caught hold of by the natives and plundered, but no attempt at retaliation had been made by the crews. Had things gone on well, the *Challenger* would have remained at Humboldt Bay for five days, but Capt. Thomson made up his mind not to submit to the pilfering that was going on, nor to risk the chance of a rupture, and after careful consideration and consultation went on towards Admiralty Island the same evening. During the afternoon the Captain, Prof. Wyville Thomson, and Mr. Murray managed to land on the shore of the bay by going in a canoe with some natives, and during an hour's ramble on shore, Mr. Murray had the good luck to see three of the wonderful crested ground pigeons of the genus *Goura*, which are nearly as large as turkeys.

During the next week the ship gradually made her way, with light winds and heavy rains, and close depressing, equatorial weather, past the Schouten Islands and Hermit Island towards Admiralty Island, where it arrived on the 3rd of March, and anchored in a lovely bay in eighteen fathoms; this they called Nares Bay, in compliment to the head of the Arctic Expedition, their former captain. The natives are Papuan Melanesians, but partake more of the characters of the Papuans of New Ireland and New Britain than of those of New Guinea. Here bows were unknown and the natives used spears, with heavy heads of obsidian and light shafts 6 to 7 feet long; they also use long sharp knives or daggers of obsidian, and almost every man had over his shoulder a neatly mounted little adze made of a small piece of hoop iron; a few carried implements of the same form but the cutting part made of a piece of a thick shell ground down. Here the natives made no great opposition to the party landing, only hurrying them past or away from their villages and warning their women to keep out of sight. Sometimes the curiosity of the women would overcome their discretion, and little groups would come out to see the strangers. These were anything but pleasing looking; they wore no clothing except two fringes of grass or palm-leaves. In the course of a few days all the party were quite at home with the natives and went and came as they pleased. The natives were found to be totally ignorant of the use of tobacco and pipes, but though they showed many good points yet there are other natives' suspicions that they disposed of their dead in a very economical though hideously repulsive way. Some of the small islands literally swarmed with the beautiful large nutmeg pigeons.

On the 10th of March the *Challenger* steamed out of Nares Harbour, intending to call at one of the more western of the Caroline Islands, and perhaps at some of the Ladrone group; but the explorers were so very unfortunate in the wind that they were driven to the west of both groups, and never again saw land until they sighted the Japanese coast on the 11th of April. This cruise was by far the most trying one during the commission. The weather for the greater part of the time had been excessively sultry and depressing, and before entering on it

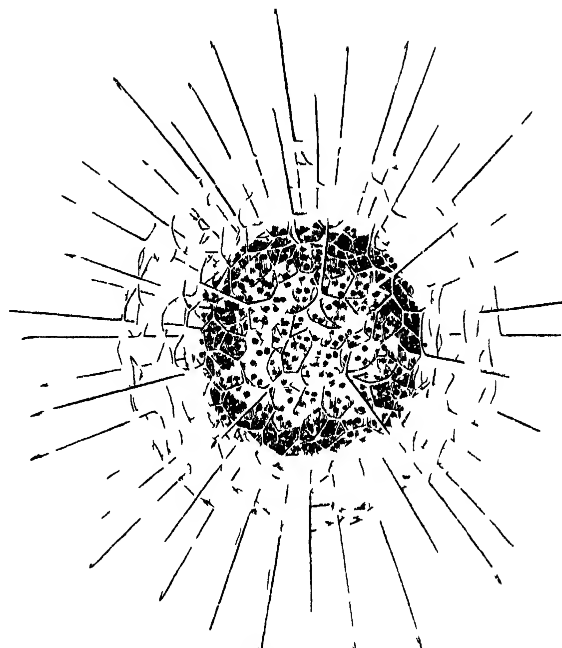

Fig. 10.—Radiolarian.

they had been nearly a year in the tropics. The section from the Admiralty Islands to Japan, 2,750 miles long, was practically meridional; the observing stations were twelve in number and pretty regularly distributed. The greatest depth was found on the 23rd of March, in 4,575 fathoms. With the exception of two soundings taken by the *Tuscarora* off the east coast of Japan, in 4,643 and 4,655 fathoms respectively, this is the deepest trustworthy sounding on record. A second sounding to check the first gave 4,475 fathoms, and in this the tube of the sounding machine contained an excellent sample of the bottom, which was of a very peculiar character, consisting almost entirely of the siliceous shells of Radiolaria. In these the body may have a more or less fully developed external siliceous skeleton, minutely fenestrated, and often presenting very remarkable and beautiful forms (Fig. 10), or the skeleton may be essentially internal and be formed of a number of siliceous spicules radiating from a centre, round which the sarcode is accumulated, as in *Xiphacantha* (Fig. 11). Or again they may give off a set of finely anastomosing branches which form one or several concentric lacey shells, which invest the sarcode nucleus as in *Haliomma*

(Fig 12) These lovely forms occurred in such numbers in this sounding as almost entirely to mask the red clay

The most marked temperature phenomenon observed in this part of the cruise was the presence of a surface layer of water at a depth of 80 fathoms and a temperature above 77° F extending northwards from the coast of New Guinea, about 20°, and westward as far as the meridian of the Pelew Islands The greater part of this vast mass of hot water is moving with more or less of rapidity to the westward

The travellers, weary and worn out by their assiduous labours in the Tropics, had a welcome and a well deserved rest at Japan The wonders of Yeddo and the freshness of the climate soon restored them to vigour Short excursions were made and various towns and villages were visited A cruise was made after a time to Kobe and along the south-west coast of Nipon, and on the 16th of June the *Challenger* left Yokohama and ran an easterly course between the parallels of 35° and 40° north latitude as far as the meridian of 155° east She then went nearly directly southwards and reached Honolulu, one of the Sandwich Islands on the 27th of July

Between Japan and these latter Islands twenty-four observing stations were satisfactorily established At the first station, just forty miles to the south of Nosima Lighthouse, they had a successful trawl and brought up a mass of starfish and other Echinoderms that was found a giant hydroid polyp apparently referable to the genus *Monocaulus* The hydranth was 9 inches across from tip to tip of the expanded tentacles, and the hydrocaulus or stem was 7 feet 4 inches high, with a diameter of half an inch This wonderful form was found once again nearer to Honolulu The deepest sounding got off Japan was 3,950 fathoms ... The temperature observations gave a ... result ... surface temperature had fallen to 6... and the belt of water above 50° F was reduced in depth to considerably less than 100 fathoms, while all the isotherms, at all events to a depth of 300 fathoms, rose in proportion There seems to be little doubt from a comparison of the American temperature results with those of the *Challenger*, that this sudden diminution of temperature is due to a cold surface flow from the ... of Okhotsk and possibly attaining its maximum at the season of the melting of the snow over the vast region drained by the Amoor and Siberian Rivers with ... overflow

The soundings from Yokohama to Honolulu ... uniform as to depth ... 2,850 fathoms and the bottom was pretty ... red clay In some cases the trawl came up half filled with large lumps of pumice which seemed to have drifted about till they became waterlogged The red clay was also found full of concretions mainly consisting of peroxide of manganese round oval or mammillated and very irregular, varying in size from a grain of mustard seed to a large potato On breaking these they are found to consist of concentric layers having a radiating fibrous arrangement and usually starting from a nucleus consisting of some foreign body, such as a piece of pumice or a shark's tooth, or such like

A delightful fortnight was spent on the Sandwich Islands, numerous excursions were undertaken In the Government Library at Honolulu there was a splendid collection of scientific books, which enabled many points in the natural history of some of the species found to be verified On the 11th of August Hawaii was visited and the crater of Kilauea was explored On the 19th Hawaii was left, and the course of the *Challenger* was due south to Tahiti Many soundings and dredgings were made on the way the average depth being 2,800 fathoms, with a bottom of red clay, and many things of great interest to the biologist were discovered Tahiti was reached early in September, and amid the charms of this island, by some better known as Otaheite, the time sped quickly until October every opportunity was made use of to get acquainted with the productions, climate, geological structure, and inhabitants of the island Leaving it on the 2nd a section was made across to the island of Juan Fernandez a distance of about 4,000 miles with an average depth of 2,160 fathoms Juan Fernandez was reached on the 13th of November, and two days were spent exploring every corner of it, and large collections were made The ship anchored in the harbour of Valparaiso on the 19th Three weeks were here spent to recruit, and then the *Challenger* ... on the 10th of December, started on a cruise round Cape Horn to the Falklands

1876

The Falkland Islands were reached about the 10th of January and some three weeks being spent in explorations among the islands on the South American Coast, Monte Video was visited on the 15th of February, when, after a week's sojourn homeward was the cry, and on the 23rd the *Challenger* left for her last section across the Atlantic in the direction of Ascension Island and St Vincent At the Cape de Verd Islands she once more was in familiar waters and had encircled the world The former was reached on the ... th of March, and a week was spent at George Town when stores were completed and a few supernumeraries taken on board On the 18th of April St Vincent was reached and the final start for home made on the ...th, her arrival at Spithead on the 24th of May is now a matter of history We are glad to be able to report that all of both staffs are in the enjoyment of perfect health

This sketch of the *Challenger* cruise has, from the very necessity of the case been an imperfect one time and space both failed or we would have gladly told of visits to Heard Island the strange breeding place of the giant albatross of fights with sea elephants and of many of the new and rare animals found in the depths of the three oceans We would here also like to have subjoined a sketch of the chief scientific results of the voyage but perhaps it were better left undone, for we know that a "Narrative of the Cruise of the *Challenger*" from the able pen of the head of her civilian staff, is already in an advanced state of preparation From the glimpses we have got of it from the beauty of the illustrations some of which adorn this sketch) that will appear in it we feel sure that it will be one of the most deeply interesting as well as fascinating books published It will be not a mere enumeration of events, but contain, as well descriptions and figures of all the new forms forming a most worthy contribution to Physical Geography, to Ethnology and to Zoology and Botany

In conclusion we append a tabular abstract of the voyage of the *Challenger*

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Sh...	I... t... l	I... 7	Wed Dec 21 72	
P...rt... l	I	I	F... Jan 3 7	1
L...l	C...r...l	J... 1 7	S...t J... 18	
C... ltar	M...l	S... J... (	M... F... 3	
M... ler... a	I... l	W... l... l	I... Feb 7	
C... n... ll... I	ff			
Te...ffe	St. II	F... I... 14	S... M... 6	2
St. II... s	I	M... M... 4	Fr... April 4	
I... la	H... l... f... N... Y	M... April 21	Fr... M...	1
H...	I... r	M...n M...	...t M...	
B... h	St. M... l... el A	Fr...lay J... 1	F... J... l... 4	
St. M... la	M...	W... J... l	... J... 5	
M... l	S... V... t	Th...r J... ly 7	S... J... 7	
St. V...nt	I... Fr...a	T...es A	Th...n A... 7	
F... tc... l...	St... l... K... l	S...t A...	W... A... 27	1
St. I... l... s... I... k	F... l... No...	F... A	M...n Sept 1	
F... l... N	I... l	W... I	Sun Sept 14	
Bahia	C... of G...d Hope	Thur S... l... 5	Tues Sept 28	3
	T... l... f... l... t Se... of Voyage			19

and gurnard, which lie in well-arranged confusion at a little distance, whilst in No 186, a carefully painted dog fish and skate are seen lying on some crab pots In No 234, 'Crabbers,' there is abundance of motion in the boat which is just taking in a wave over the bows as one of the fishermen hauls in the crab pot, but what shall we say of the fine male crab which he is extracting? The face of the crustacean is towards the spectator, but will it be believed that an artist of Mr Hook's experience has actually placed the huge claws *behind* the legs, instead of in the *front*! Think of the outcry there would have been, if in that over discussed horse in the "Roll call," about whose action nobody could agree, the artist had chosen to put the fore legs where the hind limbs should have been it would have been treated as an insult to common sense, for every one knows, or thinks he knows, the points of a horse But a mere crab, poor *Cancer pagurus*, what does it matter where his nippers are placed? We sincerely hope that when Mr Hook has occasion to paint a live lobster he will not paint it red, although this would be by far the more trivial error of the two

It is needless to say anything of Mr T S Cooper's cattle pictures, for we have seen the same kind of thing as long as we can remember In 243 'An Inquisitive Magpie," Mr Jones has some brown sheep in a brown atmosphere, contemplating a stuffed magpie on a hurdle the picture is hopelessly "skied but it may be satisfactory to the artist and to Mr P A Duffy, whose excellent 'Flood in the Dargle hangs next at a similar elevation, to know that their works help materially to tone down the too advancing brown of the tree trunk in Mr Leighton's "Daphnephoria, hung immediately below

"Early Summer 105, by Mr H W B Davis A, is a clever landscape with Devon cattle, but by far the greatest work which has ever proceeded from his brush is 'Mares and Foals, Picardy' (557, a picture which may challenge comparison with any similar subject by Landseer In the foreground a foal, bitten by a fly plainly visible on its neck, is plunging wildly over another foal which is lying down, the centre figure is a large white mare whinnying and showing her teeth at another member of a group which seems generally out of temper whilst the mare and foal to the left in repose, are simply perfection The great mass of white in the centre is most difficult to manage, and in certain lights there is something not altogether satisfactory about the shoulder on the off side, but when the direct glare of the sun does not fall on the picture, this apparent defect disappears

Mr B Riviere has not been fortunate with his Ducks in a 'Stern Chase (513 and the art critics do not seem favourably disposed to his (496) "Pallas Athene and the Herdsman's Dogs but putting the figure of the goddess out of the question, the dogs, which are uncommonly like wolves, are really well drawn, and the attitude of the one rolling on its back is excellently given There is much humour in the expression of the bull mastiff looking down on the skye terrier in Mr O Weber's 'How do you do (416), and as they are stated to be portraits, we cannot quarrel with the head of the former, but his chance of a prize at a dog show would be small In 'Home Ties' (435), Mr E Douglas gives us a foxhound and litter in kennel, and in 556, 'A Bagged Fox, a capital fox terrier, standing on and watching intently the movements in a sack, from which the bagged fox is just gnawing his way out, in the foreground are two red herrings tied to a cord indicating that the hounds are generally hunted on the drag, and that a fox is an unwonted luxury probably he has been purchased to give a brilliant wind up to the season Two other sporting pictures 231, by W H Hopkins, and 557 by S Pearce, are commendable

Mr Ansdell has abandoned Spain this year, and all his pictures, but one represent Scotch scenes In 214 we have the well known black and white ponies, whilst 619 represents some half drowned sheep recovered by the shepherds the foreleg of the sheep standing upright are absurdly small and out of all proportion The colly-dog which has just killed a hill fox caught in the act of devouring a lamb 524 is painted in that artist's usual style for in dogs he has now no rival, but we miss the life and expression which Landseer used to give to his canine friends Mr P Graham's 'Moorland Rovers' (585), a couple of shaggy Scotch cattle would look better if they were painted on a smaller scale, and the green of the reeds in the foreground strikes us as somewhat vivid in colour

Mr Heywood Hardy's 809 is a somewhat ambitious attempt to represent an extremely difficult subject—the animals coming to Noah's ark It would appear that the artist started with the intention of confining his choice to members of the African or Ethiopian fauna there are ostriches giraffes, African elephants and buffaloes, sable antelopes Dorcas gazelles and other species whilst the most obtrusive figures are those of two hippopotami, one of which is opening its enormous jaws to their fullest extent The deep red of the interior of the beast's mouth has unfortunately necessitated a very serious departure from the original plan and led to the introduction on the right of the picture of two scarlet *Ibis* or *Ibises*, whose office is clearly to tone down the red of behemoth's mouth We are not altogether satisfied with the presence of the Syrian bear, the horse, and the wild ass in such company The foreshortening of the pelican's wing on the left is also incorrect and, indeed, the birds in general are not satisfactory but we have to thank Mr Hardy for clearing up a point which has hitherto been unexplained We never could understand why the raven never returned to the ark but after viewing the bird which has looked up wistfully at Noah's feet, and evidently wondering how he is to get up there without anything to walk upon we see that it is only too plainly From the moment that Noah inhumanly 'sent him forth his minutes were numbered, a couple of despairing flops of his incapable wings, and unless Noah promptly lowered a boat, the corpse of the corpse devourer must speedily have become the sport of the waves which then united the Black and Caspian Seas But with all its defects, Mr Hardy's picture is a most meritorious attempt at portraying animals as they really are, nearly every species has evidently been drawn from the live specimens in the Zoological Gardens and we sincerely trust that the artist will persevere in the line which he has selected

Miss A Havers has been very fortunate in her delineation of geese in 'Goosey, Goosey Gander' (1260) a girl sitting on a foot bridge at evening, watching a flock of geese wading in the burn one of the flock is leaving the rest and waddling off to the wrong side of the water It is not every one who can paint a goose, and it would be difficult to imagine a more accurate representation of the ungainly motions of that despised bird Equally good in its way is the rendering of the action of a mule just at starting, in Mr W J Hennessy's 'Fete, Normandy" (523 which has moreover a charming composition

It is sad to have to notice such painful failures in animal painting as those of Mr C Landseer, R A, "A Watch Dog" (420), and Sir F Grant's "The Muckle Hart' (1341), in the latter the recumbent stag has hardly one of his tynes correctly drawn, and the hind in the distance is a fearful and wonderful beast

With regard to the Statuary, it is difficult to find a place in the lecture room, whence a good view can be obtained of J E Boehm's enormous equestrian group of St George and the Dragon, but the dragon deserves notice as being a compound of several existing reptilian forms, thus approaching reality as far as is possible with a semi-mythical monster. The body of the dragon is that of a crocodile, the neck and head are those of the Cerastes or horned viper, whilst the wings are modelled after those

of the small flying lizard. Mr. G. A. Carter's "Group of Red-deer" (1405) is not a great success, but it will probably look better when executed in silver. There is much merit in Mr. W. Pitha's "Polar Bears" (1455), in which the artist has coloured the snouts and slightly washed the limbs of the animals with yellow to relieve the deadness of such a mass of white, an excusable innovation in the present instance. And last in order we come to two admirable models of "A Wild Boar" (1501), and "A Bear" (1507), by Mr. Joseph Wolf, whose reputation as a delineator of animal life with the brush is unrivalled, but who has never till now turned his attention to modelling. The attitude of the boar is excellent; his face is devoid of any expression, although he has evidently partaken of some vegetables whose remains lie at his feet, but withal there is no sign of enjoyment or satisfaction. It is otherwise with the bear, who has been devouring honey-comb, and who is now licking his chops with an expression worthy of a gourmand, showing that the good things of this life are by no means wasted upon a gentleman of his appreciation. And with this we close our notice of animal life at the Academy, congratulating artists in general upon the increasing tendency to paint their subjects from nature instead of evolving them out of their own inner consciousness. TWO NATURALISTS

THE ETHNOLOGY OF THE PAPUANS OF MACLAY COAST, NEW GUINEA

IN December 1873 when at Batavia I received from the Russian traveller Von Miklucho Maclay reprints of two articles upon the East Coast of New Guinea and its inhabitants, of which I made a short abstract for NATURE (Feb. 26, 1874) during my voyage from Java to Atchin. The following is the substance of one of two supplementary papers on the same subject,[1] which have been lately sent to me, by Dr. Maclay, from Johore on the Malay peninsula, which it would be imagined should be all the more interesting, as much which is to say the least doubtful has lately been published about New Guinea and its natural productions.

The former papers dealt with the individual characters of the Papuans, while in the present article the food, weapons, dress, dwellings, and daily life of this people will be treated of.

The Food of the Papuans.—That of the inhabitants of Maclay Coast is principally of a non-animal nature, consisting of fruits and vegetables, of which a list is subjoined in the order of their domestic importance.

The Cocoa-nut (*munki*).—This plays a most important part in the economy, as it is obtainable all the year round. The trees are seldom to be met with in the mountain villages, but are numerous on the shores of the neighbouring islands, though here they are confined to plantations around the houses. A favourite dish which never fails at feasts is *munkila*, a kind of porridge made of the grated kernel of the nut steeped in the so-called "milk." Curiously enough, the preparation of cocoa-nut oil is unknown.

The Dioscorea (*ajan*) is much cultivated in the plantations, and is in condition for food from August till January. It is boiled in water, or when this is difficult of carriage, roasted in ashes. It forms the principal article of diet during the above-named months.

The Collocasia (*bau*) is the main article of food from March to August. Like the *ajan*, it is either boiled or baked. Pounded up with grated roasted cocoa-nut, it is made into a kind of cake, which is in great request at feasts. The leaves of the plant are also eaten.

The fruit of the Convolvulus (*degargol*), of which there are two varieties, one red, the other white, is principally in season in September and October, and is either stewed or baked.

Although no less than eight or nine varieties of Banana (*mogá*) were met with by Miklucho Maclay, owing to its limited cultivation the fruit is a comparative rarity. The lower part of the stem and the roots of the young plants are also eaten.

On account of the rare occurrence of the Palm affording it, sago (*buam*) is rather a dainty seen only at feasts, than an article of daily diet.

The Sugar-cane (*dn*), which attains a magnificent growth in New Guinea, the edible portion being not infrequently fourteen feet high, is chewed with the greatest zest by men, women, and children from October to February.

The Bread-fruit (*boh*), though not particularly sought after, is collected and eaten stewed or roasted.

The *Oiam* is the fruit of a tree which Dr. Maclay had no opportunity of seeing. This fruit is hung in great baskets upon the trees in the forests. From the pulp and the kernel of the crushed seed there is derived by fermentation an acid unpleasantly smelling sauce, which is considered a great delicacy.

The Canarium commune (*Keng-ii*) is collected in May, June, and July, dried, and its seed stored.

The fruit of the *Pandanus* (Screw Pine) and *Mangifera* (mango) also occurs, but very sparingly, on Maclay Coast.

Animal food is of but rare occurrence. The following animals are, however, the most usual sources of food:—

The Pig.—This, a descendant from the wild New Guinea species, is bred in the villages. When young it is striped, but with age it becomes black. The ears are erect, the snout sharp, and the legs long. Pigs are only killed on festal occasions, and then one suffices for two or three villages.

Dogs are kept by the Papuans principally for the sake of their flesh, which, though of fairly good flavour, is, nevertheless, somewhat dry.

The flesh of the Cuscus (*mai*) is considered a great dainty, although it has a strong smell.

Fowls, although they occur in the villages, are but seldom eaten, and as they exist in a semi-wild state their eggs are not often to be obtained. During a stay of fifteen months Dr. Maclay only saw two eggs in the various villages which he visited.

From the large lizards (Monitors) a white and tender meat is obtainable.

All insects without exception, especially large beetles, are eaten, either raw or cooked, by the Papuans.

As regards fishes, the larger are caught in nets, while the smaller are killed by harpoon at night time.

Various molluscs and other shell-fish are collected on the coral reefs at low water by the women and children of the villages.

As the existence of salt is unknown here, the Papuans cook their food with a little sea-water, generally one-third to two-thirds fresh water; and the inhabitants of the hills never omit to take away with them a bamboo filled with sea-water when they visit the coast. The Papuans have, nevertheless, a substitute for salt, for they collect the tree-trunks which, after soaking for a while in the sea, are cast up at high tides, dry and burn them, and thus procure therefrom a saltish tasting ash.

The manufacture of intoxicating drinks is, moreover, not unknown among the Papuans. They take the stem, leaves, and especially the root, of a certain shrub called "Keu" (*Piper methysticum*[1]); this they chew, and the resulting mass, when sufficiently masticated, is spat out with as much spittle as possible into a cocoa-nut shell. A little water is added to this, and, after the dirty green looking brew has been filtered through some grass, the filtrate, which is very bitter and aromatic, is drunk off. This liquor does not taste particularly good, as is proved by

[1] "Ethnologische Bemerkungen über die Papuas der Maclay-Küste in Neu Guinea." Reprinted from the *Natuurkundig Tijdschrift* of Batavia.

[1] A small bush equal to that mentioned to New Guinea.

the grimaces of the natives as they drink; very little, too, goes a long way, for a small wine-glassful suffices, in half an hour, to make a man unsteady upon his legs. Old people only are allowed to indulge, for it is strictly forbidden by custom to women and children. The Papuan *keu* appears to be identical with the *kava* of the Polynesians, only these latter add more water.

The *cuisine* is in every way more elaborate than among the Polynesian aborigines, both as regards variety of dishes and the use of earthenware. Though food is mostly prepared with sea-water, the Papuans, nevertheless, know how to roast flesh or fish, or bake it, enveloped in leaves, in the ashes. As on account of the climate cooked food will not keep long, the Papuans either roast (e.g., in the case of the Colocasia and Dioscorea) on the morrow the remnant of that which is left to dry, or *vice versa*, as is the case with fish, which is fried immediately after it is caught, and stewed with vegetables on the following day. By this means the millions of mildew spores and mycelia which in a few hours invade and pervade all food, whether roast or boiled, are arrested in development, and so rendered harmless. The men help the women in the preparation of food; in fact, on festal occasions and on the entertainment of an honoured guest, this is done entirely by the men alone. On ordinary occasions the husband cooks for himself alone and the wife for herself and the children apart. The two sexes *never* eat at the same hearth, or out of the same dish.

The domestic utensils consist of earthenware pots of various sizes, and of wooden dishes. They are of the following varieties:—

Pots (*wab*).—These are usually of the same shape, being almost round, and tending somewhat to a point at the bottom. They are made in a few coast villages and in the neighbouring islands, and, though generally prepared with great care, bear but few ornamentations—these consisting either of straight lines, rows of dots or small curves, evidently impressions of the nails. The mountain people do not understand this manufacture, and so must obtain their pots either by present or by barter.

The wooden utensils (*tabir*) consist of large round or oval plates and bowls, and seem very cleverly made, considering that the only tools used in their construction are either of stone or of bone. They are finally smooth polished with fragments of shells, and a black dye is then rubbed in. The "tabir" forms, with the weapons, the most important possessions and articles of barter for the Papuan.

The shells of the cocoa-nut (*ure*) are used as plates by the lower members of a family, as it is only for the father of the family or for a guest that food is served in the large wooden bowls.

A kind of fork (*aursan*) is used at meals, consisting of a pointed stick. Three of these are sometimes tied together, and are then generally carried in the hair, as they also serve the purpose of head-scratchers.

The *kai* is a kind of spoon made from a cocoa-nut or mollusc shell, while the *schelun* is made from a flat splinter of kangaroo or pig's bone, and can be used either as a knife or shallow spoon.

A very important implement, the *jaur*,—is made merely from a smooth shell, in which teeth are cut with a stone. This is used to grate the albumen of the cocoa-nut, which is usually only eaten in this form.

The implements and arms are as follows:—"If we look at," says Maclay, "their buildings, their *pirogues*, or canoes, their utensils, and their weapons, and then cast our eyes upon the stone axe and some fragments of pebbles and shells, *we must perforce be struck with astonishment if only at the great patience and skill displayed by these savages*." The axe, which, though their chief implement, is, no one will deny, a tool simple enough, consists of a hard, grey, green, or white stone, which has become smooth and sharp by long polishing. Hatchets have been seen by Maclay in the "Archipelago of Contentment" which were made out of a thick clam (*Tridacna*) shell, instead of from stone. A portion of the stem of a tree which has a branch passing off at an angle, somewhat like the numeral 7, is hewn off, and upon the branch, which has been cut off short and shaven flat at the top, the stone is laid horizontally and bound fast with lianas or various kinds of tree barks. Such an implement can only be used to advantage by one accustomed to handle it; otherwise, either the stone is broken or nothing results. The aborigines, however, can with their axe, having a cutting edge of only two inches in breadth, fell a tree trunk of twenty inches in diameter, or carve with the same really fine figures upon a spear. Every village possesses a large axe or two having a cutting edge about three inches broad and which is wielded with both arms, while the ordinary axe of two inches edge is employed with the right arm only. The stone of the hatchets, a kind of ... ite, is confined to the mountain people, and is not found in superfluity. Each adult is in possession of one good axe, the large ones being kept by their owners as things of the utmost value and rarity.

Fragments of flints and of shells are used to put the finishing touches to work done in the rough with the stone axe, the shells being preferred to the flints, as being not so brittle. All sorts of devices can be carved upon bamboo with shell fragments. The great combs of the Papuans and the bamboo boxes in which the lime for betel chewing is kept, as well as their arrows, furnish instances of this art.

The *dongan* is a pointed or flatly split bone, having the shape either of a dagger or of a chisel. For the first-named part in the bones of the cassowary and (but rarely) those of man are used, while those of pigs and of dogs are employed for the latter form. The "dongans" are used for cutting either raw or cooked fruit, and are generally carried on the arm, being supported by the armlet.

A knife is made from the bamboo by removing the inner woody fibres at the edge of a fragment, so that only the sharp siliceous outer part is retained. With this meat and fruit and vegetables are cut up, while the *dongan* is never used for cutting, but only for splitting and piercing.

The weapons comprise:—

1. The *ararr*, a spear used for throwing, about 6 ft. 8 in. in length, and made of a hard, heavy wood. It is the most dangerous and most universally used of the Papuan weapons.

2. There is also a longer, but lighter, spear the *sarauru*, tipped with a sharpened piece of bamboo, which after a victim has been struck, breaks off from the shaft and remains in the wound.

3. The *urar* is a bow, about two yards long, the string of which is made from bamboo.

4. The arrows, *aral*, are about one yard long, of which the tip is as much as a third or a quarter of the shaft in length, and is sometimes provided with barbs.

5. A most dangerous kind of arrow, *ferom* by name, is of the same size as the preceding, but resembles the *sarauru* in having a broad bamboo tip. For catching fish there is yet another variety of arrow, the *saran*, provided with four or five points. When fishing by torchlight, the Papuans use the *jur*, a harpoon with numerous tips of hardened wood, and furnished, in order that it may not sink, with a bamboo shaft.

The inhabitants of the neighbouring islands *Bili Bili*, *Jambomba*, *Graged*, *Tiara*, &c.—possess in addition large shields, about a yard in diameter, made out of a hard wood, and ornamented with carvings. Miklucho Maclay's coast neighbours had nothing of the kind. In some of the villages he saw long flat sticks, about a yard

and a half in length, which must be wielded, much like the large ancient swords, with two hands [1]

Sling-stones are also in use in time of war. The principal weapon of warfare, however, is the above mentioned *chadga*, which is dangerous up to a range of from thirty five to forty paces. The arrows can scarcely be considered dangerous above fifty paces range, because they are too light. In war time, and in hog hunting, the tips of the spears and arrows are rubbed with a red earth, but the Papuans in this neighbourhood do not poison their arrows.

Regarding the dress and ornaments of the Papuans the sole article of clothing of the men is the *mal*, a kind of cloth prepared from the bark of trees, having a length of more than three yards and a breadth of about a quarter of a yard. This article of dress is manufactured in a way similar to that of the *tapas* of the Polynesians, the outer layer of bark is detached, and then beaten with a piece of wood upon a stone until it becomes soft and supple, after which it is dyed with a red earth. It is worn thus: one end having been held fast on the belly, at the navel, the cloth is passed between the legs, and then carried several times round the waist, the end being finally tied with the first end in a knot at the back. As much traction is exercised upon the part which is pushed between the legs, the anterior end comes to hang down in front. The corresponding dress of the females, also called *mal*, consists of fringes about half a yard long, fastened to a girdle, which hangs down in thick clusters as far as the knees, and does not embarrass the movements of the body. This garment is generally dyed in black and red horizontal stripes. In some villages the *mal* of the girls up to the time of marriage consists of a girdle, to which two bunches of dyed bast are attached, one hanging down in front, the other over the middle of the buttocks, and when they sit down they carefully pull the hinder and longer bunch between the legs. These young ladies also carry on either side of their buttocks ornaments of shells and coloured fruit stones. Besides the *mal*, the Papuans possess long and broad pieces of cloth similarly prepared, which they wear over the shoulders in the night and early morning, as a protection against cold.

The ever constant companions of the Papuan are his *[illegible]* and his *[illegible]*. The former is a small bag carried round the neck, containing tobacco and various small articles; while in the latter, which is larger, and is slung over the left shoulder, he carries a box of quicklime for betel chewing, his *[illegible]*, *[illegible]* and *[illegible]*, shells, and bamboo boxes containing red and black dyes and other necessaries. These bags are woven out of variously coloured threads, and ornamented with shells.

The men carry on the upper arm, above the biceps, bracelets called *[illegible]*, artfully woven out of bark or grass, and ornamented with shells. Stuck in such a ring the *dongan* is carried. Similar rings, or "bangles"—*[illegible]*—are worn above the calves. A highly prized ornament, worn hanging from the neck over the breast, is the *[illegible]*, wild boar's tusk.

The men also wear broad earrings of turtle shell or of wood, or in default of these, pieces of bamboo, longish stones, or flowers. The women have two kinds of earrings. From either ear lobe hangs one or several rings, or from the upper edge of one ear there passes a cord across the forehead to the corresponding part of the other ear, while from either extremity of the cord a bundle of white dogs' teeth hangs down on the side of the neck. The women also have two bags—*[illegible]*—which are much larger than those of the men, and are carried on the back, slung by a band round the forehead. In one of these fruit is brought daily from the plantations into the villages, while in the other the newborn children, or else young pet pigs or puppies, are carried.

J. C. GALTON

(*To be continued.*)

[1] Could these not be used, like similar weapons employed by certain tribes in the heart of Africa, for parrying blows?—J. C. G.

THE MUSEUM OF COMPARATIVE ZOOLOGY, CAMBRIDGE, U.S.[1]

THE Report of the Museum of Comparative Zoology for the past year, which has just reached this country, is of great interest, as it gives us an account of the way in which the supporters of this noble Institution have endeavoured to meet the blow it suffered by the premature death of its founder. The Penikese School of Natural History succumbed, we know, after a faint struggle, but it does not at all appear that the Museum of Comparative Zoology is likely to follow its example. A fund of 260,000 dollars has been raised by public subscription, as a memorial to Agassiz, which is to be devoted to the completion and endowment of the Museum, and the State of Massachusetts has granted a further sum of 50,000 dollars to the like object. As more than the amount, stated to be necessary for the purpose has thus been received, we trust there can be no doubt that the desired object will be attained, and the building finished and its staff endowed according to the plans formed by the late Professor Agassiz.

The general work of the assistants in the Museum of Comparative Zoology during the past year has, we are told, "as usual consisted mainly in preparing materials for exhibition and packing the duplicate collections for exchange." The late Professor Agassiz accumulated, as is well known, enormous masses of specimens of every class in alcohol. But the present Report says:—

"The great difficulty of preserving alcoholic collections, the unpleasant nature, and enormous expense of the work, make it imperative, not only for storage, but still more for exhibition purposes, that they should be restricted to a minimum, and limited as far as possible to those classes where no other mode of preservation is practicable. The constantly increasing facilities of travel, the comparative economy with which fresh specimens can be studied, the superiority of such work with proper appliances to that of the Museum, the daily increasing number of workers who are able, on the sea shore or in the field, to produce results unattainable by Museum study, all go to show that the time has come when large collections must naturally be supplemented by zoological stations. These, when once established at properly selected localities, will enable Museums to dispense with much that is now exceedingly costly. They will become, for certain departments at least, chiefly depositories where the record of work done at the stations—the archives of natural science, so to speak—will be preserved, so that, while their usefulness for the general instruction of the public and of our higher institutions will not be diminished, they must hereafter be useful to the original investigator in a somewhat more limited field."

There can be no doubt of the sagacity of these remarks. They should be well considered by the supporters of the Aquariums now springing up in every direction, which might easily be so arranged as to be useful also as Zoological Stations like that at Naples.

The most important addition made to the collection at Cambridge in 1875, appears to have been that formed by Mr. Alexander Agassiz during his expedition to Peru and Bolivia. This, we are told, contains a "fair representation of the fauna of the high plateau in which Lake Titicaca is situated." A preliminary account of the materials collected is now being published in the "Museum Bulletin." The fishes and reptiles will be described by Mr. Garman, the fossils by Prof. O. A. Derby, the crustacea by Mr. Faxon, the birds and mammals by Mr. Allen, and Mr. Agassiz hopes, himself, to be able to give a short account of the physical geography and geology of the district.

[1] Annual Report of the Trustees of the Museum of Comparative Zoology at Harvard College in Cambridge, together with the Report of the Curator to the Committee of the Museum, for 1875. Boston, 1876.

Thanks to the generosity of the Pacific Mail Steamship Company in passing the baggage free, Mr. Agassiz and his companion took to Peru a large outfit in the way of ropes, dredges, sounding-leads, thermometers for deep-water temperatures, and all the necessary materials for preserving large collections.

Though they were greatly disappointed in the variety of animal life found in the lake of Titicaca and the surrounding shore, they took some very interesting deep-water temperatures (to a depth of 154 fathoms), and completed a preliminary hydrographic sketch of the Lake, which has furnished valuable results, and done much to explain the poverty of its animal life.

The success of the Memorial-fund, of which we have spoken above, will, it is anticipated, enable the principal ideas of the late Professor Agassiz to be accomplished, so soon as the necessary additions to the buildings are completed.

"The foundation will then be laid of an institution in which the claims of college-students, of teachers, of special students, of advanced workers, and of original investigators will be considered, as far as the means and space of the establishment will allow. The public will find in the exhibition-rooms all that is likely to be of interest from the stores of the institution, labelled and arranged so as to be not only instructive, but suggestive.

"Of course time alone will enable us to fill out and complete this plan. We shall be compelled at first to make a very unequal exhibition, but as the blanks become apparent they will be filled.

"From our stores necessary materials for the constantly increasing number of students are to be supplied, and one of the chief duties of the Curator must always be to meet the reasonable demands of those charged with the instruction, by supplying them with ample materials suited to the wants of the different classes engaged in study at the Museum. The special students will have at their command, under proper regulations, in the store and work rooms, of the assistants, the materials of the department in which they are interested.

"To the original investigator the resources of the Museum will always be available, under generous restrictions, with facilities for the publication of investigations made with Museum materials, as far as the means of the institution will allow. On the completion of the additions proposed at present, the Museum will thus consist of several departments of natural history, formerly separated in the University, and now all more or less intimately connected."

In concluding our notice of this report, we shall, we are sure, to be heartily joined by every European naturalist in wishing that these excellent plans of the Director of the Museum of Comparative Zoology may be speedily and efficiently carried out.

THE GREENWICH TIME SIGNAL SYSTEM[1]

II.

We have now to speak of the use made of the time signals beyond the Observatory walls, and will first refer to the hourly currents passing to the Post Office. The original time-distributing apparatus was comparatively simple; afterwards Mr. C. F. Varley devised the chronopher, an elaborate system of switches and relays provided with an accurate clock for opening and closing the switches at the proper times, and forming together a complete automatic system; but on the transfer of the central telegraph station from Telegraph Street to the new building in St. Martin's-le-Grand, it was found necessary to add a second and much larger chronopher, shown in the accompanying drawing. It is to this apparatus that the Greenwich wire is led, and by which the single Greenwich current is simultaneously retransmitted on many different lines. These lines may be considered as divided into four groups :—1, the metropolitan; 2, the short provincial; 3, the medium provincial; and 4, the long provincial. The first group consists of wires passing to points in London; the second of wires passing to towns within a moderate distance of London, as Brighton, &c.; the third of wires passing to greater distances, as Hull, &c.; and the fourth of wires passing to towns or places at a considerable distance, as Belfast,[1] Edinburgh, Guernsey, &c. In each of the four groups the London ends of the several lines are brought into direct connection, each group having its separate battery and relay. On these four relays (the two at the left hand and two in the centre of the six shown) the current from Greenwich acts, and in each relay circuit the local battery current so divides that a portion of it passes out on every wire of the group.

The distribution in London takes place every hour; these wires, being used for time-signal purposes only, remain always connected to the metropolitan relay. To the country, distribution is made twice only on each day, at 10h. A.M. (by the new chronopher), and at 1h. P.M. (by the old chronopher), using the wires of the ordinary telegraphic service, which have, in consequence, to be specially switched into connection with the chronopher. The action at both hours is similar; we shall therefore describe only the 10h. A.M. distribution, which is the more extensive. Shortly before 10h. the chronopher clock (not shown in the sketch) sets in motion the clockwork train shown in the centre of the drawing; this turns over on its axis the flat bar (extending from side to side across the row of upright springs), which pushes the springs backwards, each one out of contact with its corresponding little square stud above. Each spring is in connection with a distant town or telegraph station, the corresponding stud communicating with its particular speaking instrument in the London office. As soon, therefore, as the springs are pushed back, the speaking instruments become all cut off, and the springs (representing distant stations) remain in contact with the long bar. This bar consists of three insulated portions, one for each of the three groups of provincial wires, each having its own battery and relay as before mentioned, and when it comes into contact with the springs in the way described, the distant stations all receive a constant current which serves as warning. On arrival of the Greenwich current at the chronopher the relays act and reverse these battery currents, and these reversals of current indicate at the distant stations the hour of 10h. A.M. precisely. Shortly after 10h. the clock-work train causes the long bar to turn back into its ordinary position, the springs become restored each to its respective stud, bringing the lines all into communication with their several speaking instruments, and the ordinary telegraphic work goes on as before. Of two relays on the right in the drawing, one (by action from the chronopher clock) opens out the relay coils a few seconds only before the hour, and so prevents interruption from accidental currents in the Greenwich line; the other is concerned in the Westminster clock signalling, spoken of further on. The galvanometers are for showing the passage of the various currents of which we have been speaking.

In some cases the current drops a time-ball on the roof of a building, in others a model time-ball is exposed to view in some place accessible to the public; sometimes the current acts on an electric bell, or ordinary galvanometer, and in some cases a gun is fired. The last-mentioned manner of communicating time to the public is one of the most generally useful for ordinary purposes, provided that the observer makes allowance for the rate at which sound

[1] Continued from p. 52.

[1] It is to be remarked that although the signals pass into Ireland, Greenwich time is counted only in Great Britain, Dublin time being counted throughout Ireland. In regulating clocks in Ireland by the Greenwich signals, allowance has therefore to be made for the constant difference between Greenwich time and Dublin time

travels (about four miles in nineteen seconds). Time-guns are thus automatically discharged at 1 P.M. daily at Newcastle, Sunderland, Middlesboro', and Kendal.

The action of the apparatus, both at Greenwich and in the Post Office, is entirely automatic. Still, in the extension of the system, inquiries have sometimes been made as to the degree of exactness of signals received through the chronopher; the accuracy of its transmission has therefore been tested by direct experiment. One of its distributing wires was connected to a wire returning to Greenwich, so that the current leaving the Royal Observatory to act on the chronopher could be directly compared with that received at Greenwich from the chronopher. The currents were made to pass through galvanometers placed side by side, but there was no sensible difference in their indications. It follows, therefore, that entire confidence can be placed in the distribution by the chronopher.

As showing the extent to which demand for the automatic chronopher signals has increased, it may be mentioned that for some years past the *British Postal Guide* has contained a tariff of annual charges for which the telegraph department will supply such signals and maintain the special connecting wires, both in London and the country.

The automatically transmitted signals are scientifically accurate, but a very extensive practical distribution of time is also made daily at 10 A.M. by hand contact. In

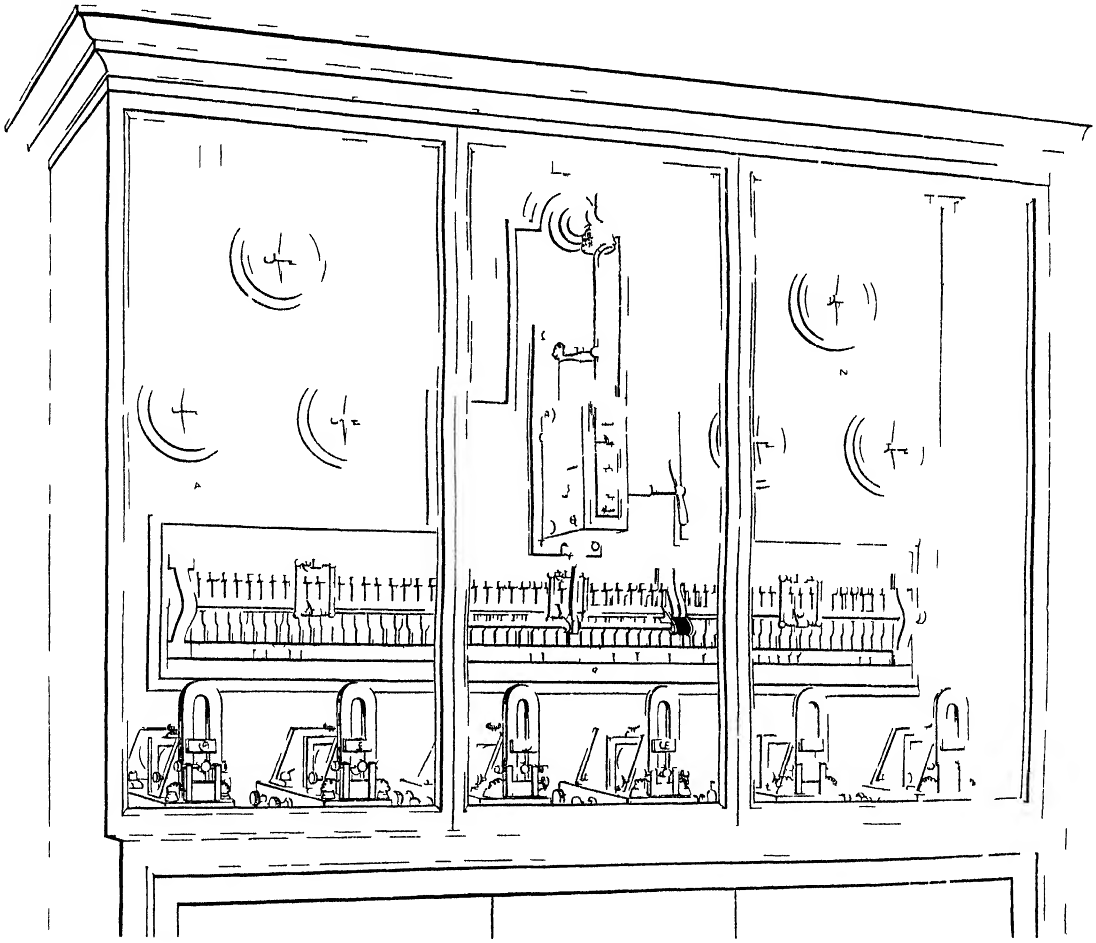


Fig. 2.—New Chronopher (or time distributing apparatus) in the Central Postal Telegraph Office, St. Martin-le-Grand.

the large instrument room of the central telegraph station a "sound" signal is established in connection with the chronopher. When heard at 10 A.M., the clerks, being in readiness, immediately transmit signals by their ordinary speaking instruments to above 600 offices in direct communication with the central station, including those in towns not supplied from the chronopher, the London offices, and the principal London railway termini. At many of these offices the signal is redistributed to others radiating from them, and so practically regulates most of the post office and railway clocks of the country—these in their turn, insensibly as it were, regulating the clocks of the surrounding districts.

Thus, either by the accurate chronopher signal, or by the arrangement spoken of in the preceding paragraph, the 10h. current each morning from Greenwich, through the Post Office telegraph system gives time simultaneously in all parts of the United Kingdom.

One of the chronopher lines in London passes to the clock tower of the Westminster Palace, and hourly signals are received at the clock for its necessary rating and adjustment. It is, however, in no way controlled or mechanically acted upon by the time currents. Practically, the clock requires to be very rarely touched; if change becomes necessary, it is usually made by adding to or removing from the pendulum small auxiliary weights. The clock also completes a galvanic circuit at a certain time daily, and so transmitting a signal, reports

its rate at Greenwich. The statement of the Astronomer Royal in one of his annual Visitation Reports, that the rate of the clock "may be considered certain to much less than one second per week," does not, we believe, overestimate its performance. As regards its absolute variation from true time, we find, according to his last report, that on 83 per cent. of the days of the preceding year its error was below one second. We may mention that the clock has a gravity escapement, that the compensation of the pendulum is entirely metallic and generally similar to that of the Greenwich Sidereal Standard (described in our article on that clock), and that the first blow on the bell at the hour is true clock time, it having been made a condition in the construction of the clock that there should be no loss of time in the first stroke.

So far as regards the work done from one of the wires passing from the Royal Observatory: on the other, terminating at London Bridge, currents also pass from Greenwich hourly, which, with the exception of that at 1 P.M., are placed at the disposal of the South-Eastern Railway Company, who in return give to the Royal Observatory, for two or three minutes daily at 1h., communication between London Bridge and Deal for the purpose of dropping at the latter place a time signal ball belonging to the Admiralty, placed on the old semaphore tower (part of the now abolished Navy Yard). For communication with Deal at 1h. a clock at London Bridge (one of those before spoken of as being controlled from Greenwich) automatically switches the Greenwich wire into communication with a wire on the main line of the South-Eastern Railway. Other special connections are also daily made at Ashford and Deal before the current can pass uninterruptedly from the Observatory to the time-ball; immediately after 1h. the wires are restored to their former positions. To ensure that the ball has fallen properly at 1h., an arrangement exists by which, after its discharge and before it has completed its descent, it makes such momentary changes of the wire connections as cause a "return" signal to pass to Greenwich indicating that it has fallen. This ball was established by the Admiralty to give Greenwich time to shipping in the Downs, and has been in use since the year 1855. It is placed under the superintendence of the Astronomer Royal, who in his annual Visitation Reports gives statistics by which we can judge of its practical working. Examining these reports for the last few years we find, on the average, that about once in two months the ball was not raised on account of high wind, and that about once in six weeks, from accidental telegraphic fault, there was no discharge. An erroneous drop appears to be rare, happening once or so in a year. When such does occur, a black flag is at once hoisted as indication of mistake, and the ball is then dropped at 2h. The efficient working of the ball, thus distant from the Observatory, is considered by the Astronomer Royal to be mainly due to the establishment of the return signal which immediately makes known at Greenwich whether the ball has fallen in the usual way.

Excepting the 1h. current, used as described for the Deal ball, the remaining hourly currents to London Bridge are distributed by Mr. C. V. Walker mainly on the lines of the South-Eastern Railway. For this distribution the clock at London Bridge, already spoken of, switches at different hours different wires into connection with the Greenwich wire, and so passes on the Greenwich current; at some hours it goes to the office of the British Horological Institute in Clerkenwell, for the use of watch and chronometer makers.

It will be seen that the country generally is well served by the system now described, but a useful extension would be made by the establishment of authoritative signals in favourable positions on our coasts, for the purpose of giving to mariners the means of obtaining Greenwich time and approximate sea rates for their chronometers after leaving port. One coast signal only at present exists—the time-ball set up at Deal, as already described. Some few years after its erection, however, it was suggested that a time-signal should be also exhibited every hour at some headland of the southern coast, and after some discussion of localities, the Astronomer Royal proposed a detailed scheme for showing such signals on the Start Point. And more recently the Shipowners' Association of Liverpool made inquiry as to the facilities for exhibiting a similar hourly signal on the Tuskar Rock. Neither of these schemes has yet been carried into execution, but, excepting the question of cost, there seems to be otherwise no difficulty.

It was indicated in an early part of our article that one of the objects of connecting the Greenwich Observatory with the telegraphic system was the possible determination of differences of longitude between Greenwich and other observatories by the exchange of galvanic signals, and since such connection has existed, many important determinations of the kind have been made. We cannot here enter into any detailed description of the different plans that have been from time to time employed in practically carrying out such operations: it will be sufficient to say that the longitudes of the principal British and of some continental observatories have been thus determined. On two occasions Atlantic cables have been employed for fixing the positions of points in America, and more recently (in connection with the Egyptian expedition for observation of the late Transit of Venus) the longitude of Cairo has been by similar means determined. In the latter operation signals were exchanged between the submarine cable stations in Cornwall and Alexandria with perfect success, through one unbroken line of submarine wire. The telegraphic method of determining longitude is one of the most accurate that can be employed.

The connection of the Royal Observatory with the telegraph assists scientific inquiry and even commercial enterprise in various unexpected ways. Capt. Heaviside, R.E., having recently been engaged with some pendulum experiments at the Kew Observatory, it only became necessary to connect the telegraph line at Greenwich to the Sidereal Standard for a few minutes daily, to enable him to receive seconds signals through the Post Office wires, and so refer his observations directly to the Greenwich clock. Also, in the laying of Atlantic cables, an accurate knowledge of Greenwich time being of the greatest importance for the exact navigation of cable ships, Greenwich time has on such occasions been daily passed from the Royal Observatory through the cable itself, as it was being submerged, to the ship.

Our object has been simply to describe the Greenwich system, but we may mention that the plan of telegraphing time, first carried out at Greenwich as part of the daily routine, has since been adopted in other places. In Britain much has been done at the observatories of Liverpool, Edinburgh, and Glasgow, for the dissemination of a knowledge of accurate Greenwich time, both by public clocks and public signals, in the vicinities of those cities. A time-gun is fired daily both at Liverpool and Edinburgh by signal from the observatories of those places. Time-signal systems in connection with observatories are also in operation in various of our colonies, and in places abroad. In the United States of America several very extensive systems have of late years been established, and it has recently been proposed to regulate the clocks of Paris from the Paris Observatory.

The system of employing the ordinary telegraph service of a country for the daily transmission of time in many directions from a fixed observatory shows the benefit that may sometimes ensue from uniting for a special object the powers of two separate institutions of totally different character. The astronomer must for his own particular work obtain from the face of the sky that which, especially in our day, is also so useful to mankind, an accurate

knowledge of the flow of time. This he can, with slight additional trouble, communicate to the external world, although wanting the means of promulgation to any great extent. Telegraphs, on the other hand, exactly supply this want, and can spread abroad in all directions the astronomer's information. Before the transfer of the telegraphs to the State, the successful working of the Greenwich system was due entirely to the existence of amicable arrangements entered into by both parties. But now that the time signal system is, as it were, consolidated, it might well receive greater development. The principal clocks, and those of public institutions, in our large cities and towns, London included, should be more directly regulated than is at present the case by the automatic signals which can be so readily supplied by telegraph, and which might usually be received (as at Westminster) in the clock tower or chamber, for direct comparison with each particular clock. In large towns one wire could be made to serve for many buildings, and the cost for each thus greatly reduced.

The efficient regulation of public clocks in the way mentioned is however a thing entirely for the consideration of the municipal bodies in the various cities and towns concerned. But it is otherwise with the question of the establishment of signals on our coasts for the giving of Greenwich time to outward bound or passing vessels. This is a matter not merely of local, but of national interest; and since the whole subject of the safety of our ships at sea is now under the consideration of the Imperial Legislature, it seems a proper time to direct attention to the usefulness of such coast signals, as tending directly to the improvement of navigation, and thereby contributing in an important degree to the further protection of shipping.

MIGRATION AND HABITS OF THE NORWEGIAN LEMMING

WITH all our recent knowledge of the Northern Fauna, and the ample opportunities of the Scandinavian naturalists, the animal in question still seems to have evaded a thorough scrutiny and complete solution of the why and wherefore of its remarkable migrations. Ten consecutive summers spent in Norway have led Mr. W. Duppa Crotch,[1] in studying the creature, to propound a novel view as to the impetus of its recurrent irruptions. Passing by the traditional lore respecting its sudden appearance in myriads, he discountenances the later informed writers' explanation of hunger, or of the approach of severe weather, being the cause. Even "survival of the fittest, with its cogent subsidiary clause," according to our author, fails to serve as a substantial reason, for, as he observes, none of the travellers survive. His own theory is a very simple one. The bands of migrants always head westward, and at last, in diminished numbers, perish in the sea. In one well authenticated instance (Collet), a ship sailed for fifteen minutes through a swarm, the water being literally alive with them far as the eye could reach. This migratory instinct, Mr. Crotch assumes, is hereditary, their progenitors in the good old times of a colder age having sojourned in a land of plenty, now submerged beneath the Atlantic. ...

completed in one year, as formerly supposed, nor do they, as stated, form processions and cut their way through obstacles; but breeding several times in the season, they gather in batches, and at intervals make a move westward. Their pugnacity, he states, is astonishing, and the approach of any animal, or even the shadow of a cloud, rouses the anger of this small creature like a guinea pig, and they back against a stone or rock uttering shrill defiance. Our author found, in most examples, a bare patch on the rump, due to their rubbing against the said buttress of support when at bay. He wonders why a bare patch, and not a callosity, should not result from this innate, apparently hereditary habit. They cross wide lakes by swimming, but when in the water they are easily frightened and lose all idea of direction, and are inevitably drowned by a slight ruffling of the surface. It seems the reindeer trample them under foot whenever the chance may occur, and other enemies in the shape of hovering rapacious birds and small carnivora thin the numbers considerably as the Lemmings in force drive westward. The writer also called attention to the fact that fossil remains of the Lemming exist in England, as an evidence that the animal had penetrated hither before the island was severed from the continent. The subject altogether is a most interesting and suggestive one, well worthy of the investigation and observation of northern sojourners. Even the recent view of Mr. Crotch, it seems, does not set the whole question at rest. There possibly may be some physical or physiological reason underneath; at all events it is certainly remarkable how a settled westward course is that chosen, calling to mind the similar direction which races of men are assumed to follow.

THE SEYCHELLES ISLANDS

THE Report mentioned below is dated 20th May, 1875, and refers to two visits made to the Islands of the Seychelles group in 1871 and 1874. The islands visited by Mr. Horne were Mahé, Praslin, Silhouette, La Digue, Felicité, Curieuse, Aux Frégates, St. Anne, and Aux Cerfs. The soil, climate, and products of the islands are very similar, so that the remarks made are equally applicable to all of them. The climate is healthy, although the islands are situated almost under the equator, and the Cascade Valley in Mahé, which is at an elevation of 1,500 feet above the sea, is pointed out as being especially delightful. The seasons are two, the warm and wet during the north-west monsoon from October to April, and the comparatively cool and dry season from April to October. The rainfall during the year is about 90 inches, most of which falls during the wet season.

Some of the islands have high mountain peaks, as Mahé, with an elevation of 3,000 feet, and Silhouette with an elevation of 2,500 feet, the highest land in the other islands is less than 1,500 feet. Lagoons often exist between the base of the mountain and the flat sandy beaches which exist in all the islands. In former times crocodiles were abundant in the lagoons, but they have now been extirpated.

The islands are granitic with veins of trap. Coral reefs are abundant but of small size, the largest being on the north-east of Mahé and the north-east end of Praslin. The surface of the islands is mountainous and undulating. Granite boulders are common, and are most numerous near the mountain tops and at the bottom of ravines. The soil is rich and capable of producing any kind of crop peculiar to the tropics. In many places, however, the soil has been washed away, and some of the islands are almost bare rock. There is much uncultivated land, the greater proportion of which is good, but according to Mr. Horne the people are either too lazy or too ...

The chief produce of the islands is cocoa-nut oil and fibre. The plantations of cocoa-nuts are increasing, and many of the young plants are now bearing, which they do when ten or twelve years old. The value of a plantation in full bearing is about three shillings per tree per annum. The oil is extracted by the old primitive mill which has been used in Ceylon and elsewhere for hundreds of years. The fibre is extracted by machinery and will soon

[1] In a paper read before the Linnean Society, May 4.

Report on the Seychelles Islands. Addressed to the Honourable ... J. Horne, Sub-Director, Royal Botanic Gardens ...

form an important item in the exports from the country. The cocoa-nut thrives very well in the Seychelles, and plantations exist from the sandy beaches up the slopes of the mountains to elevations of from 1,000 to 1,500 feet. Tobacco was formerly much cultivated, and was of very fine quality, but the imposition of a tax on tobacco seems to have stopped the cultivation, and Mr. Horne says "the value of the tobacco grown would scarcely suffice to pay the tax, independently of the return which might be expected for their labour." Sugar-cane is cultivated to a small extent to make rum, but although the canes are magnificent, the yield of sugar is small and unremunerative. Cotton also grows remarkably well, but the cultivation has died out since the abolition of slavery, owing to the want of labour during the picking season. The chocolate plant grows freely on waste lands, and its culture is progressing. Vanilla has been planted in several places, and these plantations will shortly be bearing.

Maize and rice are but little cultivated, although in some places two crops of the latter might be obtained each year.

Spices, as cloves, cinnamon, nutmegs, allspice, and pepper thrive well. Clove trees are abundant and attain a height of 40 to 50 feet. The islanders gather the cloves in a reckless and extravagant manner, often felling the trees when the cloves might be reached by a bamboo ladder. The cinnamon is the bitter cinnamon, and is comparatively worthless. The nutmeg and allspice trees were introduced in 1871, and here thrive well. Pepper (*Piper nigrum*) is abundant, climbing over the granite boulders like ivy, and much might be made of it if a few Chinamen or Malays were introduced. Vegetables are very scarce, chiefly from the indolence or indifference of the inhabitants. Manioc and sweet potato are abundant, but yams are very little cultivated. The inhabitants obtain most of their food from the *Colocasia esculenta*. Arrowroot has been planted, and ginger, turmeric, and cardamoms might be easily cultivated. Mr. Horne recommends the rearing of silkworms and the cultivation of coffee. Mulberry-trees grow very readily, and coffee seems formerly to have been cultivated. The only drawback seems to be the want of labour. Pine-apples are abundant but of inferior quality, while oranges are common and excellent. Limes and bigarades are not uncommon, and lime-juice was formerly manufactured to some extent. Other tropical fruits, as anonas, bread-fruit, &c., are common.

During Mr. Horne's two visits he collected about 400 species of plants. About half that number are plants inhabiting all tropical countries, the greater portion of the other half will find congeners in Madagascar, Eastern Tropical Africa, Southern India, the Malay, Polynesian, or Oceanic Islands. The Flora of the Seychelles has no affinity to that of the Mauritius, and Mr. Horne considers that the relations to the Flora of Madagascar will be important from the similarity of geological formation and climate. He also thinks that the Seychelles Flora will have much in common with that of Eastern Tropical Africa. Mr. Horne's specimens have been sent to Kew, and will doubtless be described in the forthcoming Flora of Mauritius and the Seychelles. The Flora seems small, but vegetation is in many places scarce, owing to the occurrence of fires and from the ravages caused by the reckless felling of trees. Much of the ground is covered with dry Palm and Pandanus leaves, which easily take fire. The fire-tracks are readily distinguished by the age of the trees and shrubs now found growing on them.

The palms of the Seychelles are very interesting. The first is the Coco-de-Mer or Double Cocoa-nut. It abounds at Praslin, in a ravine, the highest trees measuring from 80 to 90 feet. The tree growing near the Government House at Port Victoria has flowered for the first time at about its thirty-fourth year. The other native palms of the Seychelles are all *spiny*, viz., a species of *Areca*, *Stevensonia grandifolia*, *Verschaffeltia splendida*, the "*Latanier Haubaum*," and another undescribed species. *Areca rubra* (?), *Hyphæne* sp., and *Latania rubra* or *Borbonica*, have probably been introduced.

Articles, as hats, &c., of almost infinite variety are made from the young leaves of the Coco-de-Mer. The leaves of *Stevensonia* are used for thatch, and the split stems of *Verschaffeltia splendida* make excellent palisades. Ropes are made from the leaves of *Curculigo Sechellarum*, and fibre for cordage is got from *Paritium tiliaceum*. The fibre of *Fourcroya gigantea* (recently introduced) is made into fishing lines. The gum copal of Madagascar is got from *Hymenæa verrucosa*, a rare tree in the Seychelles.

Many useful timber trees are met with. The chief are the following :—

"Capucin," a species of *Siderexylon*.
"Takamaka" (*Calophyllum inophyllum*).
"Bois de Fer," a species of *Dipterocarpeæ*.
"Gayac" (*Afzelia bijuga*).
"Badamier" (*Terminalia badamia*).
"Bois de Natte" (*Imbricaria petiolaris*).
"Bois Marée," a species of *Gomphandra*.
"Bois Rouge" (*Wormia ferruginea*).
"Bois de Table" (*Heriteria littoralis*).
"Sandal," a species of *Rubiaceæ*.
"Bois Montagne" (*Campanospermum Zeylanicum*).
"Cèdre" (*Casuarina equisetifolia*).

Mr. Horne carefully describes the uses of these timber trees.

The ordeal nut of Madagascar (*Tanghinia venenifera*) is met with in the Seychelles. It is a small tree about twenty feet in height, with large clusters of pretty white flowers having a pink centre.

Pigs are fed on the boiled roots of the *Colocasia macrorhiza*; all parts of the plant are poisonous if unboiled.

Pitcher plants, *Pandani*, and species of *Loranthus* are common; Ferns are tolerably numerous, and include the *Cyathea Sechellarum*, *Angiopteris evecta*, &c.

Mr. Horne recommends the Government to purchase the Coco-de-Mer ravine, to prevent the destruction of the trees, and he very properly adds, that "the destruction of the trees would be an outrage on science and a disgrace to civilisation."

Trees seem to be felled quite indiscriminately—a portion of the tree selected, the rest left to rot—so that now good trees are only to be found in the most inaccessible parts of the mountains. We trust that Mr. Horne's report will not be overlooked by the authorities; otherwise we may soon expect to hear that the Seychelles are merely barren rocks and every trace of vegetation gone.

W. R. M'NAB

THE LOAN COLLECTION CONFERENCES

SECTION—PHYSICAL GEOGRAPHY, &c.

Opening Address by the President, John Evans, F.R.S.

In opening the Conferences in connection with this Section of the Loan Exhibition of Scientific Apparatus, it will probably be expected that I should say a few words, if only by way of explanation, of the class of subjects that come within our range, which indeed are neither few nor unimportant. Let me first take the general list of subjects which have on the present occasion been grouped together, and which may be said to constitute our domain. These are Meteorology, Geography, Geology and Mining, Mineralogy, Crystallography, &c. Some of these subjects might no doubt with almost equal propriety have been assigned to other sections. Meteorology might for instance have been classed under the head of Physics and Mineralogy would not have been altogether alien to

the Section of Chemistry. There is, however, so close and intimate a relation between all the various branches of physical research, that it is not only difficult to draw exact boundaries between their provinces, but also to determine to which group any given province shall belong when it becomes necessary to map out the whole field of science into some four or five divisions.

Our province may be regarded in the main as comprising the physical history of the earth—the constitution of its mineral parts and the forms and characters they present when crystallized, the geological succession and nature of its component rocks; the past and present distribution of land and water, and the causes which have led to its modifications; and lastly those meteoric influences which not only affect climate, but are active causes in the carving out of the earth's surface and in the redistribution of the materials of which it is composed. Nor do we only take the purely scientific and theoretical portions of our subjects, but also the application of scientific principles to produce economic results, and to lessen the dangers of those who in the exercise of their calling meet the forces of nature under some of their most destructive aspects.

It is of course only with the apparatus which has been devised for the purpose of carrying on the investigations into the physical history of the earth, and the applications of scientific principles which I have just mentioned, that we are mainly concerned, and not with abstract questions relating to any branches of science. It may, however, be found necessary to enter more or less into such abstract questions if only to show the character of the investigations which have to be pursued, and to elucidate more fully the difficulties with which inquirers have had to contend, or which still have to be conquered. Such questions may also have to be discussed should the history of the gradual development of some of our modern appliances be gone into. Some of the earlier forms of instruments which are now exhibited are indeed of great interest, whether they are regarded in the light of what may be termed milestones on the road of scientific progress, or as memorials of the eminent men by whom they were devised or used. The goniometers of Hauy and Wollaston, the nascent safety-lamp of Davy, the blowpipe of Plattner, the barometer of De Luc and H. B. de Saussure, the thermometer of Gay Lussac, the geological maps of William Smith, the logbooks of Cook, Franklin, and Parry, the instruments and maps of Livingstone, are replete not only with scientific but historical interest.

It is, indeed, as constituting an epoch in the history of scientific discovery, that such a collection as that among which we are now assembled has its highest value and interest. The third quarter of the nineteenth century has just come to its end, and we may venture to compare the advances which have been made during the last twenty-five years not only in our own particular walks of science, but in every branch of it, with the advances which had been made during the previous quarter of a century, the close of which was marked by the first Great Exhibition held in London. Great as had been the progress in scientific knowledge and in the application of scientific principles during that second quarter of the century, and favourably as it contrasted with the by no means despicable attainments of the previous quarter, the advances made during the last twenty-five years both in our knowledge of the principles of the great forces of nature and in the accuracy and delicacy of our instruments for their investigation are such that the present generation has at least no cause to be ashamed of them. Possibly when another quarter of a century has elapsed, those who come after us and those among us who survive as labourers in the field of science, may look back upon some of the processes now in vogue as antiquated, and may even feel surprise at our having been upon the verge of some great discoveries and yet having failed to make them; but I venture to hope that the names of many of those living investigators which we find recorded in the Catalogue of this Exhibition may not only then, but even in after ages, be looked upon with reverence and esteem.

We must, however, turn to the consideration of the branches of science comprised under this Section, and in directing your attention to some of the objects which appear to me of more than common interest, I shall venture an occasional observation on some matters which appear to be well fitted for discussion at an international conference such as the present.

In regard to meteorological instruments we have not only isolated specimens but sets of instruments as supplied to meteorological stations, and to the royal and merchant ships of this country. With the exception of Russia, however, the means of comparison with other countries are, I believe, wanting. It will be for the representatives of other countries to see whether some useful hints may not be derived from the experience of British meteorologists as embodied in these selections of instruments.

Mr. R. H. Scott in the "Handbook to the Collection" has given so excellent an account of the nature of the meteorological instruments here exhibited that I need add but little to it, especially as he will be good enough to make a communication upon them.

Taking the principal forms it will be seen that among the barometers there are more than one exhibited which are of historical interest, while numerous examples of modern improvements in mercurial barometers are shown, of which perhaps those intended to facilitate their use and increase their accuracy when employed by travellers by land and by sea, are the most noteworthy. For ordinary use, however, that comparatively recent form of barometer, the Aneroid, seems likely to compete with the older form, and the precision of mechanism which some of them exhibit is marvellous. That extreme delicacy, however, has its disadvantages, and for trustworthy observations the actual weighing of the atmosphere by the column of mercury will long be preferred.

The principal features of the thermometers are their accuracy and sensitiveness. It might be worth while to consider whether any means could be devised for facilitating the adoption of a uniform scale of notation. It will, however, be a difficult matter to supersede the scale of Fahrenheit in this country, where it seems to have taken so deep a hold. The more general introduction of instruments marked with both Fahrenheit's and the centigrade scale might assist the adoption of the latter, but the smaller unit of heat on the former scale gives it practically some advantage.

Of anemometers, both for meteorological and mining purposes, a large number will have been seen, some of them furnished with means of recording both the direction and strength of the currents. Of several of these, details will be given at this Conference.

With respect to rain-gauges but little need be said, unless it be to call attention to the system, which, thanks to Mr. G. J. Symons, is now so universal in this country, viz., for observers who make only one daily entry of the rainfall, to take their observation at 9 A.M. and to enter the amount of rain to the preceding day. The late Meteorological Congress has no doubt discussed this and other points of international interest.

Of hygrometers, both ancient and modern forms are exhibited, the hair hygrometer still holding its own among those of the indirect class, notwithstanding the influences of modern civilisation. One cannot but be touched by the pathetic note of the Geneva Association for constructing scientific instruments. "The most isolated hamlets have now to be searched in order to obtain hair uncombed," and therefore fit for these instruments.

It is perhaps in the self-recording instruments that the greatest advance made during the last quarter of a century will be observed. The extended use of electricity and

photography has aided in this as much as in other departments of science, and the daily weather charts now issued in this country would have been impossibilities but a few years ago.

The automatic light-registering apparatus of Prof. Roscoe will it is hoped be the subject of a communication to the Conferences of this Section; but this and several other recording instruments are fully described in the Catalogue, as are also various interesting charts illustrative of meteorological influences on mortality and disease. The relation which has been found to subsist between colliery explosions and the state of the weather will form the subject of some observations to the Conference by Mr. Galloway.

There is only one other point in connection with meteorology on which I will say a few words: that of evaporation. Two or three forms of atmometers or evaporimeters are exhibited, some of them intended to determine the quantity of water evaporated from different kinds of soil, but no form of instrument is, I believe, in the collection which will serve to ascertain the proportion of the rainfall which percolates to any given depth through a porous soil. When it is considered how large a proportion of the surface of the globe consists of such soils and how important is the question of the supply of spring-water to our wells and rivers, it will perhaps be a matter of surprise that more attention has not been directed to the subject. It is not, however, one on which to enter at length in an introductory address, though I hope to recur to it in the course of the afternoon.

The second subject comprised within our Section is that of Geography, which, thanks to our distinguished African, Asiatic, Arctic, and marine explorers is at the present time attracting so much public attention. Many of the instruments exhibited have much of historical and personal interest, among which may be reckoned the series of instruments belonging to the Ordnance Survey, some of them—like Ramsden's theodolites exhibiting to what a point the construction of such instruments had advanced even at the end of the last century. What, however, will attract universal attention are the deep sea sounding appliances, which have so greatly conduced to the success of the *Challenger* Expedition, and the great extension of our knowledge of the character of the deep-sea deposits of modern times, which throw so important a light on the history of many earlier geological formations.

This interest is much enhanced by the satisfaction we must all feel in again welcoming among us the distinguished naturalist who has had the scientific charge of that expedition. Let us all hope and trust that the gallant captain of the expedition during the first portion of its voyage, may in like manner return in due course with his present comrades from his still more adventurous exploration of the Arctic regions, crowned with the success which his efforts so well deserve.

Among the deep-sea sounding apparatus, that most ingenious invention of Dr. Siemens, the bathometer, which has been exhibited and described in another Section, will, no doubt, have attracted your attention, of which many of the levelling and surveying instruments exhibited in this Section are also so well worthy.

The collection of maps requires but little comment. The survey of Palestine, the charts of the Arctic Regions, the survey maps of India, and the beautifully executed maps sent from foreign countries cannot escape attention. In connection with recent explorations the remarkable section across Southern Africa, executed by Lieut. Cameron during the perilous journey from which he has just returned, will, I hope, be the subject of comment in these Conferences by its distinguished author. Nor should the ancient maps of the sources of the Nile exhibited by the Royal Geographical Society be left unnoticed. It might be a subject for discussion whether some more uniform system of symbols for use on maps might be adopted for general use among all nations.

In the department of Geology and Mining, it may be observed that the instruments of the pure geologist are but few and comparatively simple. We have, however, before us a most valuable collection of the geological maps of various countries, showing how vast has been the advance of our knowledge in this field during the last quarter of a century. The principles on which the geological survey of this country has been directed will be illustrated by its present accomplished chief, Prof. Ramsay, and we shall, I hope, hear something as to the surveys now going on in other countries. It would be a matter well worthy of consideration in an assembly of this kind, whether for the general geological features of a country, some international system of colouring could not be agreed upon, and in future be adopted. For more detailed maps entering minutely into the subdivisions of formations, such a system might be difficult to devise, much more to carry out; but for the principal formations there ought surely to be no great difficulty. Already, for something like two centuries, the colours in heraldry have been represented all over Europe by a conventional system of vertical, horizontal, oblique, and other lines, and science would not suffer if on this occasion she walked in the wake of vanity.

Among the appliances of the geologist must be reckoned his palæontological and mineralogical collections which, however, are, except in special instances, too bulky for an exhibition of this kind. Some are, however, here, and among them, a magnificent series of rocks, minerals, and fossils from Russia, and the fossil vegetable remains, both from the Continent and England, well deserve notice. We shall, I hope, hear from Baron von Ettingshausen how the genetic descent of much of the flora of the present day may be traced back into Tertiary times, and Mr. J. S. Gardner will have something to say on the same subject.

The sub-wealden boring, which has attained a depth of 1,900 feet, without, however, reaching any rocks of Palæozoic age, will also form a subject of comment. The process of the Diamond Rock Boring Company by which it has been carried on, has not only the advantage of being more expeditious than the older process, but has the great merit of producing such excellent cores as those which can be seen at the end of this gallery.

The ingenious machines of Mr. Sorby, illustrative of various geological phenomena, and the original drawings of Buckland and Phillips will also attract attention.

The specimens illustrative of M. Daubrée's experiments on the artificial formation of metamorphic and other rocks, and the minerals formed within the historical period by means of hot springs, will be rendered doubly attractive by the account to be given of them by that eminent geologist.

As objects of historical interest, however, the collections illustrative of the development of Davy's great invention of the safety-lamp, are perhaps unrivalled in this department. Among mining appliances and models, some few will form the subject of communications to the Conferences.

In the remaining department of this Section, that of Mineralogy and Crystallography, there is much of historical as well as scientific value. The improvements in the microscope, the polariscope, and the goniometer, have done much to advance these branches of science during the last quarter of a century, while the application of photography to the reproduction of the images observed in the microscope has most efficiently aided in bringing the results of single observers within the reach of all.

The models and diagrams illustrative of the different systems of crystallography and the various forms of crystals are remarkably excellent and complete, and some questions in connection with the properties of certain

forms of crystals, and the method of notation best adapted for international use, will probably be discussed in the Conference.

I have thus briefly touched upon some of the salient points which occur to the mind when taking a cursory view of an Exhibition such as the present. In doing so I have no doubt passed over many instruments and appliances of even greater importance than those which I have thus succinctly mentioned, and have probably left untouched many topics of the highest interest. Among the subjects, however, which will be discussed on each day of our Conferences there will, I hope, be a sufficient variety to give occasion for any one to call attention to any special features of novelty in the collection. What I have ventured to say must be regarded as merely a short introduction to communications of far greater value, from which I will no longer detain you.

SECTION BIOLOGY

Opening Address by the President, Prof J. Burdon Sanderson, M.D., LL.D., F.R.S.

It having been made a part of the duty of the chairman of each of the sections into which this Exhibition is divided to deliver an opening address, I had no difficulty in selecting a subject. I propose to place before you a short and very elementary account, addressed rather to those who are not specially acquainted with biology than to those who are devoted to the science, in which I shall give you a description of a few of the methods which are used in biological investigation, particularly with reference to the measurement and illustration of vital phenomena. You are aware that the Committee, in order to render these conferences as useful as possible, have thought it desirable that we should devote our attention chiefly to those subjects of which the instruments in the collection contribute the best examples.

Now these subjects are, first, the methods of registering and measuring the movements of plants and animals; secondly, the methods of investigating the eye as a physical instrument; and thirdly, the methods of preparing the tissues of plants and animals for microscopical examination. Of these several subjects it is proposed we should to-day concern ourselves chiefly with the first. I will therefore begin by endeavouring to illustrate to you some of the simplest methods of physiological measurement, particularly with reference to the *time* occupied in the phenomena of life, leaving the description of more complicated apparatus to Prof. Donders, who will address you on Monday, and to my friend, Prof. Marey, who is with you now, and who will give you an account of some of the beautiful instruments which he has contrived for this purpose.

The study of the life of plants and animals is in a very large measure an affair of measurement. To begin, let me observe that the *scientific* study of nature, as contrasted with that contemplation of natural objects which many people associate with the meaning of the word "naturalist," consists in comparing what is unknown with what is known. Whatever may be the object of our study—whether it be a country, a race, a plant, or an animal, it makes no difference in this respect, that the process in each of these cases is a process of comparison, a process in which we compare the object studied in respect of such of its features as interest us, with some known standard, and the completeness of our knowledge is to be judged of in the first place by the certainty of the standard which we use; and secondly, the accuracy of the modes of comparison which we employ. Now, when you think of it, comparison with a standard is simply another expression for measurement; and what I wish to impress is, that in biology, comparison with standards is quite as essential as it is in physics and in chemistry. Those of you who have attended the conferences on those subjects will have seen that a very large proportion of the work of the physical investigator consists in comparison with standards. From his work, our work, however, differs in this respect, that whereas he is very much engaged in establishing his own standards and in establishing the relations between one standard and another, we accept his standards as already established, and are content to use them as our starting-point in the investigation of the phenomena which concern us.

Now I wish to illustrate this by examples. The first objects which strike the eye on entering this collection—the collection in the next room—are certainly the microscopes. But you will say, surely the microscope cannot be regarded as an instrument of measurement. In so far as it is an instrument of research and not merely a pastime, it is emphatically an instrument of measurement, and I will endeavour to illustrate this by referring to one of the commonest objects of microscopic study, namely, the blood of a mammalian animal. Now as regards the blood I will assume that everybody knows that the blood is a fluid mass, in which solid particles float. With reference to the form of those particles, all that we see under the microscope is merely a circular outline. If we wish to find out what form that represents we must use methods which are really methods of measurement. By the successive application of such methods we learn that this apparently circular form really corresponds to a disc of peculiar bi-concave shape. But I will not dwell more upon the application of measurement to the form of the corpuscles, but proceed at once to a subject that can be illustrated by an instrument before you for ascertaining the *number* of the corpuscles. It will be obvious to you—even to those who are not acquainted with physiology and pathology that the question of the proportion of corpuscles which are contained in the blood must be a matter of very great importance to determine. It has been long known that the colouring matter which is contained in the corpuscles is the most important agent in the most important vital processes of the body, because it is by means of it that oxygen, which is necessary to the life of every tissue is conveyed from the respiratory organs to the tissues. This being the case, it is evidently of very great importance both to the pathologist and to the man who interests himself in investigating the processes of nature, to be able to determine accurately what proportion of corpuscles the blood contains. Well, there are chemical methods of doing this. We can do it by determining how much iron the blood contains, because we know that the proportion of iron in the corpuscles is always nearly the same, and by determining the quantity of iron chemically, we can find out how many corpuscles there are in a certain amount of blood. But this is a long process, requiring first the employment of a considerable quantity of blood, and secondly, difficult chemical manipulations and a long time. Now by a method which has been very recently introduced, we have the means of applying the microscope even to a single drop of blood, to a drop such as one could obtain by pricking one's finger at any moment, or could take, in this way, from any patient in whom it might be desirable to ascertain the condition of the blood as regards the number of its solid particles.

The method consists in this. In order that you may understand it I will ask you to fix your attention upon this cube which I draw on the board. Suppose this cube is not of the size actually represented, but that it is a cube of one millimetre, *i.e.*, the $\frac{1}{25}$ part of an inch. How many blood corpuscles do you suppose are contained in a cube of that size? Such a cube we know to contain in normal blood about 5,000,000 corpuscles. Supposing we had a method by which we could count those 5,000,000 particles it is obvious that the task would be endless, and even if we were to take a cube $\frac{1}{125}$ part of that size, namely, a

ment. We have two electrical keys, one at the further end intended for making what is called the signal, and one here for breaking, which is placed close to the person who is to be experimented upon. Mr. Page, at any moment he likes, will act upon me by sending an induction flash through my tongue. I shall arrange the electrodes so that they shall be against the tip of my tongue, and at the moment I feel that flash I shall place my finger on the key. Then the clockwork being in motion at the same time, we shall see by the length of the depression in the tracing the duration of the process. If we take different sorts of signals, or if the person to be experimented upon is in different conditions, the time will be very different. Thus we may compare the result which will be produced when I am attending and expecting the signal with the result which will be produced when I am not attending or expecting the signal; or, on the other hand, I may compare those results with that which will be produced when I am expecting it, but Mr. Page, instead of giving it at the time I expect it gives it me at a different time; in that case the time occupied would be longer than in either of the other two cases. A great variety of different cases can be investigated in this way in which we measure the total period occupied in the reflex. The arrangement is perfectly simple. You see when Mr. Page presses on his key, which is the signal key, that a lever is set in vibration and makes a tracing, and at the same moment the voltaic current is made and the coil is acted upon inductively; the result is that an induction flash passes through my tongue which I feel, and the moment I feel it I break the current. Consequently the time between the moment at which Mr. Page makes the current by closing his key and the moment at which I break the current by placing my finger on my key, gives us precisely the time which is occupied by the reflex process. We will make two experiments, first, with the signal expected, and then unexpected: that is, in the one case I shall be on the *qui vive*, and on the other I shall not be so. (The experiments were made accordingly.) We shall now repeat the process, so that instead of my receiving the information of the making of the current by means of the excitation of my tongue, the signal shall consist in my hearing the sound of an electrical bell. In that case we shall find that, although the signal will come in exactly the same way, practically the time occupied will be very considerably longer, showing that a signal received by sound takes longer in producing its effect than one in which the signal is felt by the tongue.

In order to make all this perfectly plain I shall hand round this tracing. You will see there several experiments made with expected and unexpected signals, which show the different results obtained in the two cases.

The next question which arises, and with that I must conclude what I have to say just now, is this:—You will readily see that the exact measurement of time depends upon the rate at which this clockwork happens to be going. I happen to know that it makes twenty revolutions per second. But suppose I do not know that. In fact one would not trust to the accuracy of clockwork for such a purpose. How should I then be able to measure the duration of time so exceedingly short as the one which now concerns us? In order to do this we always come back to a physical standard, to a standard of absolute invariability which we can depend upon as being true. For this purpose we use a tuning-fork which produces vibrations, the rate of which we know, because we know the tone which the tuning-fork produces, and the arrangement which is always used for this purpose is the one shown here. We have turned off the voltaic current we used for signalling, and turned it on the tuning-fork. There are two electro-magnets on either side of the tuning-fork which react upon it, so that the moment you close the current the fork is thrown into vibration and produces its own characteristic note. All that we have to do is, during the time we are making our record, to bring this tuning-fork, which is now in vibration, into such a position that this little brass pointer shall make a tracing against the paper. If you look at the tracing I have sent round you will find there are tracings on it of a fork, which vibrates at the rate of 100 per second, consequently you have nothing to do but to translate the tracings which you have made and which correspond to the duration of the mental process which you have been investigating, into vibrations of the tuning-fork, and you get an exact measurement of the total duration of the process. While I have been doing this you hear the tuning-fork is in vibration, and Mr. Page has made the tracings. After it is varnished it will be sent round and you will see the tracing made by the fork over the traces corresponding to the different experiments we made just now.

I may observe that although the experiments made on that paper were made with myself, you find that the period occupied by the reflex is considerably longer than in the other which I sent round previously. But that one may very easily explain from the abnormal conditions under which the experiment has been made as regards myself.

I intended to go on from this subject to another mode of investigation, namely, to the very beautiful instruments which have been lately introduced for the purpose of measuring the finest differences of bulk in different organs, as for example, in the human arm, by which you can ascertain the condition of the circulation precisely by a very exact registering-measurement of the bulk of the arm;[1] but as there are several other gentlemen now ready to address you, I will defer that till this afternoon. I will now conclude what I have to say by asking you to listen to Dr. Hooker.

SCIENCE IN GERMANY

(From a German Correspondent.)

HERR v. OBERMAYER has recently communicated a memoir to the Vienna Academy on the relation of the coefficient of internal friction of gases to the temperature. If we accept for the coefficient of friction μ at t° C., the formula—

$$\mu = \mu_0 (1 + at)^n$$

where a is the coefficient of expansion of the gas, taken as basis of the calculation, then the experiments of Obermayer give the following results:—

For Air	n	0·76
Hydrogen	n	0·70
Oxygen	n	0·80
Carbonic oxide	$n =$	0·74
Ethylene	n	0·96
Nitrogen	$n =$	0·74
Protoxide of nitrogen	$n =$	0·93
Carbonic acid	n	0·94
Ethyl chloride	n	0·98

The coefficient of friction of the permanent gases is, according to these experiments, approximately proportional to the $\frac{4}{5}$-power of that of the coercible gases, and to the 1-power of the absolute temperature.

For temperatures between 150° and 300° C., air gave the same values of n as between the lower temperatures −21°·5 and 53°·5. In the case of carbonic acid a slow decrease of the exponent n with the temperature was perceptible from the experiments. W.

NOTES

ON Tuesday a visit was paid to the *Challenger* at Sheerness by several Fellows of the Royal Society, foreign men of Science, who are in London in connection with the Loan Collection

[1] The apparatus was fully described subsequently by Mr. Gaskell.

Conferences, and representatives of the Science and Art Department. Among those who made up the party were Lord Clarence Paget, Sir Henry Cole, Mr. Norman Macleod, Majors Donnelly and Festing, Mr. E. J. Reed, M.P., Professors Allman and Crum-Brown, Mr. Norman Lockyer, Professor Eccher, Baron von Wrangell, Dr. Biedermann, and others. Luncheon was served in the Ward-room, but as there was not sufficient accommodation for all the visitors many left by special train for Chatham, where luncheon had been provided in the Engineers' Mess-room. Invitations to visit the *Challenger* have been sent by the Admiralty to all the English and foreign members the Kensington Loan Apparatus Committee, many of whom have accepted them. The *Challenger* will be open to inspection to-morrow. The ship lies at present in the very spot she left when she set out on her cruise three and a half years ago, and to-day she is to be swung for the adjustment of her compasses and the taking of magnetic observations. It is thought that ten or twelve days will elapse before all the stores can be taken out to enable her to pay off.

FROM the official list of visitors to the Loan Collection during last week, which we give below, it will be seen that full advantage is being taken of the opportunity afforded :—

Monday	1,822
Tuesday	[illegible] 816
Wednesday	772
Thursday .	801
Friday	930
Saturday	

DR. DONDERS, of Utrecht, and Prof. van Beneden, of Louvain, are two of the latest arrivals in connection with the Loan Collection Conferences.

IT is proposed to hold an International Convention of Archæologists, at Philadelphia during the Centennial, and in connection with the Centennial Exposition, for the purpose of promoting acquaintance and increasing the means of information in American Archæology and Ethnology. The State Archæological Society of Ohio will provide rooms for the Convention, and the first meeting will be held in the Ohio Building, at 2 o'clock, P.M., Sept. 4, 1876. The American Association for the Advancement of Science, meets at Buffalo, N. Y., Aug. 23, at which time a Subsection of Anthropology will be formed. The Convention has been appointed near the close of the session of the Association in order that those who desire may conveniently attend both meetings. Large collections, in Ethnology and Archæology, from the Smithsonian Institution, the State Society of Ohio, and other public and private sources, will be on exhibition, and will furnish a great incentive for Archæologists to visit the Exposition. The meeting of this Convention at Philadelphia, must be regarded on that account as very opportune, and a large attendance is expected. Addresses from prominent anthropologists will be delivered, and it is hoped that a great impetus to investigations in America will be gained. Archæologists who purpose to attend are requested to bring any articles or illustrations which they may have, as the opportunity for a temporary exhibition will be given. The Chairman of the Ohio Committee is the Rev. S. D. Peet, of Ashtabula, O. European men of science who intend to be present at the Buffalo meeting of the American Association, should write to Prof. F. W. Putnam, Salem, Mass., who might be able to make arrangements, by which their expenses would be kept down.

IN connection with the great International Exhibition at Philadelphia, it is interesting to note that that city is one of the healthiest in the world, so far as the death-rate is a test. In 1874, according to an official circular just issued, with a population of 775,000, the death-rate was only 19·3 per thousand. This very favourable result is largely due to the abundant and cheap water-supply, and to the opportunities given, even to the poorest citizens, for the enjoyment of pure country air in the great Fairmount Park, which contains 2,991 acres. The most powerful influence of all, however, is the absence of that overcrowding of the population, which is the most fruitful source of sickness and death in many quarters of nearly all other large cities. This will be more clearly comprehended when it is remembered that the 817,488 inhabitants of Philadelphia are spread over an area of 129½ square miles, which are traversed by more than one thousand miles of streets and roads. The climate of Philadelphia is also, on the whole, a favourable one, although presenting many of the peculiarities common to inland localities. The mean annual temperature of the last ten years is 53·73° Fahrenheit; the average annual rain-fall is about forty-five inches.

THE Conversazione of the President of the Institution of Civil Engineers takes place to-night in the South Kensington Museum itself, instead of in the Galleries devoted to the Scientific Apparatus Exhibition, as was at first intimated.

WE are informed that the new Zoological Gardens of Calcutta will be opened on the 6th of this month, and that Mr. J. C. Parker has been appointed temporary Curator of the establishment. There is a fine show of Indian Ruminants and other ordinary Indian animals; a splendid pair of the Himalayan Bears (*Ursus tibitanus*), and likewise examples of the other Indian species, *Ursus labiatus*, *U. malayanus*, and *U. isabellinus*. Among the rarities is a cage full of the Indian Tupaia (*Tupaia ellioti*), a curious insectivorous form, of which the Zoological Society of London had living examples not long since.

THE *Pandora* left Portsmouth on Saturday on her voyage to the Arctic Regions. One of her main objects is to take out letters, papers, &c., for the officers and crews of the *Alert* and *Discovery*: these will be deposited in certain dépôts on the chance of Capt. Nares being able to communicate with the entrance to Smith's Sound. The *Pandora* takes out a very considerable number of letters and packets of various kinds, and not the least interesting news to Capt. Nares will be that of the successful conclusion of the *Challenger* Expedition. It is generally understood that, after depositing his mail, Capt. Young will make another attempt to push his ship through Peel Straits, or Bellot Straits, and Franklin Channel, and so on into Behring Straits, and thus be the first to make the North-west Passage.

IT is encouraging to find our legislators and "leaders of industry" enlightened enough to realise and plainly state the condition of this country with regard to scientific education. The place which this country at present holds in the matter of scientific industry, as contrasted with Continental countries and with America, has been frequently referred to of late both by public men and in these columns. The case was again briefly but pointedly stated by Mr. Samuel Morley, M.P., on Monday, at the Annual Meeting of the Artisans' Institute. "It was," he said, "essential that our sons of toil should become humble disciples of science if England was to keep pace with foreign nations in the excellence of her manufactures. The competition of industry was rapidly becoming a competition of intellect; and Belgium, Germany, and America were fast treading upon our heels in the quality of their manufactures. Seeing that at no period for thirty years had there been so widespread a depression in trade as at present, he thought the great importance of imparting scientific instruction, with a view to the maintenance of our position, would be sufficiently obvious to all. Unless this was brought to bear upon our manufactures, the situation of this

country would be one of great peril, and he sincerely hoped that the advantages offered to the working classes would be thoroughly appreciated by those whom the organisation was intended to benefit." We hope that sentiments like these will have due weight in the framing of our Education Codes.

WE are glad to hear that the Duke of Cleveland has directed the Shropshire meteorite to be placed at the disposal of the authorities of the British Museum.

IN October next, we learn from the *Western Daily Press*, the Bristol University College will be an accomplished fact. Professors of Chemistry and of Modern History, and Literature are to be appointed for the opening of the first session and Lectures delivered on the following subjects:—Mathematics and Applied Mechanics, Experimental Physics, Political Economy, and Classical History and Literature. It is gratifying to find that public spirit in Bristol has not only not allowed a great opportunity to pass, but has brought the College into existence, as a working institution, with praiseworthy rapidity. The council has appointed Mr. F. N. Budd as chairman, Mr. W. Proctor Baker as treasurer, and Mr. Edward Stock, secretary.

B. C. DUMORTIER'S "Hepaticæ Europæ," published by C. Muquardt of Brussels, is the only work which gives a complete account of the Hepaticæ or Liverworts of Europe, and embraces the work of more than fifty years of a veteran botanist. For a limited period, until July 1, the work is offered at a reduced price of 5fr., after which the published price will be 8fr. It is illustrated with four coloured plates.

BY authority of M. Waddington, the older pupils of the National School of Agriculture, established at Grignon, in France, left, on May 25, for the Netherlands, where, with their professors, they are to make an agricultural tour which is to last for three months. It is stated that they will come to England next year. Grignon was the first agricultural school established in France, and was purchased by the Government many years ago. The course of studies is for three years.

DR LEFORRAIN, a *licencié* in natural science, has just organised a series of scientific excursions in the vicinity of Paris. They are to take place each Sunday during the months of June, July, and August. The excursionists will receive practical instruction in geology, botany, and entomology, by competent teachers.

ON Monday June 26, an extraordinary session of the French Botanical Society will be held at Lyons. A number of botanists from Belgium and Switzerland will join the Society, and an important botanical exploration will be made. English botanists will be very heartily received. Particulars may be obtained by directing letters to the General Secretary, 84, rue de Grenelle, St. Germain, Paris.

THE eighth session of the International Anthropological and Archæological Society will be held at Buda Pesth, under the presidency of M. Francois Pulsky, General Inspector of the Public Libraries in Hungary. The General Secretary of the Buda-Pesth Congress is M. Florian Romer. An English committee will be appointed.

WE are glad to see that a second edition of Mr. W. N. Hartley's "Air and its Relations to Life," has been published by Messrs. Longman and Co. In this edition Prof. Tyndall's recent experiments are described.

WE have received Dr. C. Bruhn's monthly reports of the meteorological observations made at twenty-four stations in Saxony during 1875. To the reports which briefly summarise the results for each month is appended an interesting *résumé*, pointing attention to the more striking features of the weather during the year, and comparing these with the results of previous years' observations, and giving the annual means and extremes of all the meteorological elements at each station, together with the dates of occurrence of several interesting phenomena, such as the day of heaviest rainfall, of greatest dryness of the air, and the latest and earliest frost and snow.

IN the *Bulletin International* of the Paris Observatory of May 17 to 19, there appears an important paper by M. Belgrand, on the means of protecting Paris from the inundations of the Seine. The great flood of March 17 last marked 107½ feet on the river-gauge at the bridge of Tournelle, which is three feet less than the height to which the great flood of Jan. 3, 1802, rose, and 7½ feet less than that of Feb. 27, 1658, the greatest flood on record. With a view of protecting the parts of the city liable to suffer from such floods, M. Belgrand proposes to prolong the main drains and the embankments down the river as far as the fortifications, to isolate them completely from the river, and to keep them, by means of machinery, at their normal level. Further, to prevent the flooding of cellars, he proposes a system of drainage at a lower level than that of the cellars liable to be flooded, and having no communication with the river and the main drains, these drains to be kept at the proper level by centrifugal pumps and turbines driven by the water of the city.

WE have received the first part of the first vol. of a "Handbuch der Paleontologie," by Profs. Schimper and Zittel. It is published at Munich, by R. Oldenbourg.

MR. W. DITTMAR has just published (Edmonston and Douglas) a collection of useful Tables as an Appendix to his "Manual of Qualitative Chemical Analysis," which we recently noticed.

"ESSAY on the Use of the Spleen, with an Episode of the Spleen's Marriage, a Physiological Love-story," is the title of rather an original little work just published by Dr. Patrick Black (Smith, Elder, and Co.).

AS Supplement 47 to Petermann's *Mittheilungen*, has been published an account of Herr G. A. Haggenmacher's Travels in Somali Land. The author gives a systematic account of his observations in this region of Africa, under the headings of Narrative of the Journey, Physical Geography, Ethnography and Ethnology, Agriculture and Cattle-breeding, Industries and Trade, and a History of the Somalis.

THE latest additions to the Royal Westminster Aquarium include the following:—Hawksbill Turtles (*Caretta imbricata*), from the West Indies; Picked Dogfish (*Acanthias vulgaris*), and Lesser Spotted Dogfish (*Scyllium canicula*), presented by the Yarmouth Aquarium Society; Armed Bullheads (*Agonus cataphractus*), Greater Pipefish (*Syngnathus acus*), Sea Horses (*Hippocampus ramulosus* et *brevirostris*), Venus's Ear-shells (*Haliotis tuberculata*), from Guernsey; Sea Mice (*Aphrodita aculeata*), Purple Urchins (*Echinus lividus*), Sun Starfish (*Solaster papposa*), Mediterranean Corals (*Balanophyllia verrucaria*), Venus's Flower-basket Sponge (*Euplectella aspergillum*), from the island of Zebu, Collected and presented by Capt. W. Chimmo, R.N.

THE additions to the Zoological Society's Gardens during the past week include a Silver Pheasant (*Euplocamus nycthemerus*) from China, presented by Mr. W. Miles; a Common Barn Owl (*Strix flammea*), European, presented by Mrs. Knight; a Blue-faced Amazon (*Chrysotis amazonica*) from South America, presented by Miss M. Jukes; a Silky Marmoset (*Midas rosalia*), a Huanaco (*Lama huanacos*), an Azara's Fox (*Canis azaræ*), three Chinchillas (*Chinchilla lanigera*) from South America, deposited.

SCIENTIFIC SERIALS

THE *Journal of Mental Science*, April, 1876.—Reflex, automatic, and unconscious cerebration, a history and a criticism, by Thomas Laycock, M.D., is continued and completed in this number. The paper is very interesting. Dr. Laycock takes great pains, and is, we think, successful in making good his claim to priority over Dr. Carpenter in certain views of an advanced nature, which, if they are not already, will soon be entirely absorbed in others much more advanced.—Dr. John M. Diarmid writes in high praise of morphia in the treatment of insanity, when administered subcutaneously.—Dr. Daniel Hack Tuke gives an historical sketch of the past asylum movement in the United States, doing full justice to the enlightenment and humanity of American physicians, while recording the outstanding difference between them and their English brethren in the principle and practice of non-restraint.—A modest but suggestive paper on the use of analogy in the study and treatment of mental disease, is contributed by Dr. J. R. Gasquet.—Dr. P. Maury Deas describes a visit to the Insane Colony at Gheel, where the accumulating experience of a thousand years has produced an instinctive aptitude to manage the insane worth more in practice than the best of our consciously-formed systems.—Dr. Isaac makes some interesting observations on general paralysis.—"Arthur Schopenhauer: his Life and his Philosophy," by Helen Zimmern, is reviewed in a manner worthy the book and its subject.—The *Journal* contains other reviews, clinical notes and cases, news, &c.

Zeitschrift der Oesterreichischen Gesellschaft fur Meteorologie, Feb. 1.—In this number appears the first part of a paper by Dr. W. Koppen, on the yearly periods of probability of rain in the northern hemisphere. It is accompanied by a valuable diagram of curves. He begins by calling attention to the value of the system on which his calculations are based, namely, the mere registration of the days of which rain falls in each locality. Considering that in our latitudes changes of vapour tension and of relative humidity do not concur, it is simpler than measuring the quantity of rain or snow. The probability of a downfall depends upon two conditions, the degree of relative humidity between, say 100 and 3,000 metres altitude, and the favourable or unfavourable circumstances for the formation of an ascending current, or, firstly, on the rate of decrease of temperature with height; secondly, on the slope of the ground towards the direction of the wind, while the quantity depends also on the quantity of vapour contained in a volume of air, and so, *cæteris paribus*, on the temperature. He then gives a detailed account of the authorities from whom he has derived his materials. The selected stations are well distributed over the greater part of the northern hemisphere, including the North Atlantic, and have most of them afforded records during more than ten years. As in his former writings on the subject, he represents graphically the means of groups of neighbouring stations having similar annual distribution of rainfall, but annexes a table showing the actual numbers for each station. The diagram exhibits the probability of rain in each month for each district.

Feb. 15.—In this number Dr. Koppen concludes his remarks on the yearly periods of probability of rain. The paper, which is illustrated by elaborate tables, contains much valuable information respecting the times of year at which rain is most and least probable in a great number of countries and districts of the northern hemisphere.

Gazzetta Chimica Italiana, Anno VI., 1876, Fascicolo I.—Synthesis of the sulpho-tannic acids, by Hugo Schiff. The author in this paper treats of phenol-sulphuric anhydride, trichlorhydroquinone-sulphuric acid, sulphopyrogallic acid, sulphotannic and pentacetosulphotannic acids, the sulpho-acids of phoroglucin, &c.—On the elasticity of metals at different temperatures, by G. Pisati. In this paper the author investigates the elasticity of iron and steel, arriving at the following formula:—

$$K = \frac{P.L_0(1 + \alpha t)}{\pi r_0^2 (1 + \alpha t)^2 . l} = \frac{P.L_0}{\pi r_0^2 . l} \cdot \frac{1}{1 + \alpha t}$$

where K is the modulus of elasticity of stretching force, P the weight which acting on the length of wire L, produces the lengthening l, α is the co-efficient of linear expansion.—Modification of the process for the extraction of alkaloids in poisoning of the viscera, by F. Selmi.—On a method of detecting traces of phosphoric acid in toxicological researches, by F. Selmi.—On the use of phyllocyanine as a reagent, by Guido Pellagri.—Action of iodide of allyl and zinc on oxalic ether, by E. Paterno and P. Spica.—Chemical researches upon twelve coloured solids found at Pompeii.—The remainder of the part is occupied by extracts from foreign journals.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 1.—"On the Origin of Windings of Rivers in Alluvial Plains, with Remarks on the Flow of Water round Bends in Pipes," by Prof. James Thomson, LL.D., F.R.S.E. Communicated by Prof. Sir William Thomson, F.R.S.

In respect to the origin of the windings of rivers flowing through alluvial plains, people have usually taken the rough notion that when there is a bend in any way commenced, the water just rushes out against the outer bank of the river at the bend, and so washes that bank away, and allows deposition to

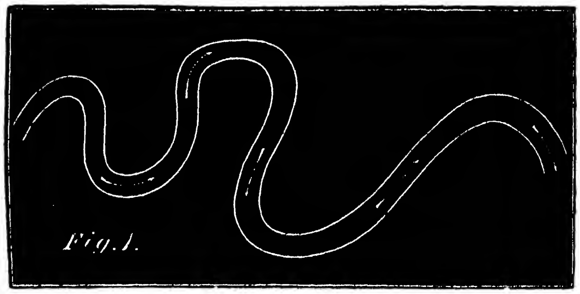


Fig. 1.

occur on the inner bank, and thus makes the sinuosity increase. But in this they overlook the hydraulic principle, not generally known, that a stream flowing along a straight channel and thence into a curve, must flow with a diminished velocity along the outer bank, and an increased velocity along the inner bank, if we regard the flow as that of a perfect fluid. In view of this principle, the question arose to me some years ago, *Why does not the inner bank wear away more than the outer one?* We know by general experience and observation that in fact the outer one does wear away, and that deposits are often made along the inner one. *How does this arise?*

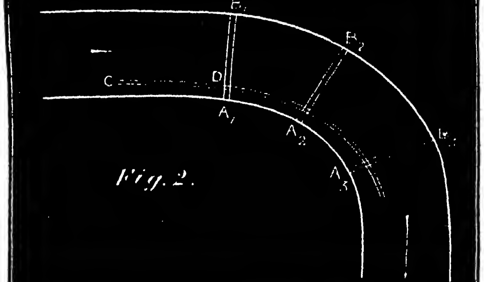


Fig. 2.

The explanation occurred to me in the year 1872, mainly as follows:—For any lines of particles taken across the stream at different places, as A_1B_1, A_2B_2, &c., in Fig. 2, and which may be designated in general as AB, if the line be level, the water pressure must be increasing from A to B, on account of the centrifugal force of the particles composing that line or bar of water; or, what comes to the same thing, the water-surface of the river will have a transverse inclination rising from A to B. The water in any stream line C D E [1] at or near the surface, or in any case not close to the bottom, and flowing nearly along the inner bank, will not accelerate itself in entering on the bend, except in con

[1] This, although here conveniently spoken of as a stream-line, is not to be supposed as having really a steady flow. It may be conceived of as an average stream-line in a place where the flow is disturbed with eddies or by the surrounding water commingling with it.

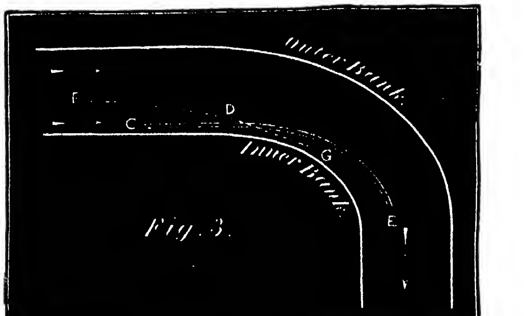
sequence of its having a *fall of free-level* in passing along that stream-line.[1]

But the layer of water along the bottom, being by friction much retarded, has much less centrifugal force in any bar of its particles extending across the river; and consequently it will flow sidewise along the bottom towards the inner bank, and will, part of it at least, rise up between the stream-line and the inner bank, and will protect the bank from the rapid scour of that stream-line and of other adjacent parts of the rapidly flowing current; and as the sand and mud in motion at bottom are carried in that bottom layer, they will be in some degree brought in to that inner bank, and may have a tendency to be deposited there.

On the other hand, along the outer bank there will be a general tendency to descent of surface water which will have a high velocity, not having been much impeded by friction; and this will wear away the bank and carry the worn substance in a great degree down to the bottom, where, as explained before, there will be a general prevailing tendency towards the inner bank.

Now further, it seems that even from the very beginning of the curve forward there will thus be a considerable protection to the inner bank. Because a surface stream-line C D, or one not close to the bottom, flowing along the bank which in the bend becomes the inner bank, will tend to depart from the inner bank at D, the commencement of the bend, and to go forward along D E, or by some such course, leaving the space G between it and the bank to be supplied by slower moving water which has been moving along the bottom of the river perhaps by some such oblique path as the dotted line F G.

It is further to be observed that ordinarily or very frequently there will be detritus travelling down stream along the bottom



and seeking for resting places, because the cases here specially under consideration are only such as occur in alluvial plains; and in regions of that kind there is ordinarily[2] on the average more deposition than erosion. This consideration explains that we need not have to seek for the material for deposition on the inner bank in the material worn away from the outer bank of the same bend of the river. The material worn from the outer bank may have to travel a long distance down stream before finding an inner bank of a bend on which to deposit itself. And now it seems very clear that in the gravel, sand, and mud carried down stream along the bottom of the river to the place where the bend commences, there is an ample supply of detritus for deposition on the inner bank of the river even at the earliest points in the curve which will offer any resting place. It is especially worthy of notice that the oblique flow along the bottom towards the inner bank begins even up stream from the bend, as already explained, and as shown by the dotted line F G in Fig. 3. The transverse movement comprised in this oblique flow is instigated by the abatement of pressure, or lowering of free-level, in the water along the inner bank produced by centrifugal force in the way already explained.

It may now be remarked that the considerations which have in the present paper been adduced in respect to the mode of flow of water round a bend of a river, by bringing under notice, conjointly, the lowering of free-level of the water at and near the inner bank, and the raising of free-level of the water at and near the outer bank relatively to the free-level of the water at middle of the stream, and the effect of retardation of velocity in the layer flowing along the bed of the channel in diminishing the centrifugal force in the layer retarded, and so causing that retarded water, and also frictionally retarded water, even in a straight channel of approach to the bend, to flow obliquely towards the inner bank, tends very materially to elucidate the subject of the mode of flow of water round bends in pipes, and the manner in which bends cause augmentation of frictional resistance in pipes, a subject in regard to which I believe no good exposition has hitherto been published in any printed books or papers; but about which various views, mostly crude and misleading, have been published from time to time, and are now often repeated, but which, almost entirely, ought to be at once rejected.

[1] It must be here explained that, by the *free level* for any particle, is to be understood the level of an atmospheric end of a column, or of any bar, straight or curved, of particles of statical water, having one end situated at the level of the particle, and having at that end the same pressure as the particle has, and having the other end, consisting of a level surface of water, freely exposed to the atmosphere, or else having otherwise atmospheric pressure there; or briefly we may say that the *free-level* for any particle of water is the level of the atmospheric end of its *pressure column*, or of an equivalent ideal pressure-column

[2] That is to say, except when by geological changes the causes which have been producing the alluvial plane have become extinct, and erosion by the river has come to predominate over deposition

Mathematical Society, May 11.—Prof. H. J. S. Smith, F.R.S., president, in the chair.—Dr. Logan was elected a member of the Society.—Mr. Tucker communicated a paper by Mr. S. A. Renshaw, on the inscription of a polygon in a conic section, subject to the condition that each of its sides shall pass through a given point by the aid of the generating circle of the conic. The inscription of a polygon in a circle, subject to the like condition, has been accomplished by several eminent geometers, in a remarkably easy manner by the late Mr. Swale. The object of Mr. Renshaw's paper is to show how, by an easy transformation, effected by means of the generating circle, the construction of the problem in the circle can be rendered available to the resolution of the same problem in the conic sections. The author draws figures exhibiting the inscription of a pentagon in an ellipse, and of a quadrilateral in a hyperbola. Mr. Renshaw also extends some other properties (for the circle) given by Mr. Swale in the *Liverpool Apollonius* (p. 45) to the conic sections.—Prof. Cayley then spoke on the representation of imaginary quantities by an (n, n) correspondence. The Chairman and Dr. Hirst spoke on the subject of this paper. Prof. Cayley having taken the chair, the President communicated two notes. The first was on a theorem relating to the Pellian equation. Let D be any integral number, let T and U be the least integral numbers which satisfy the Pellian equation $T^2 - DU^2 = 1$; and let $\Omega_1, \Omega_2, \Omega_3, \ldots \Omega_{2n}$ be the period of complete quotients of the form $\frac{\sqrt{D} + Q}{P}$ which is obtained in the development of the root of any quadratic equation of determinant D in a continued fraction. The equality

$$\Omega_1 \times \Omega_2 \times \ldots \times \Omega_{2n} = T + U\sqrt{D}$$

was established in the note, and an expression for the number of non-equivalent quadratic forms of determinant D was deduced from it. The second note was on the value of a certain arithmetical determinant. Let (m, n) represent the greatest common divisor of m and n; and let $\psi(m)$ represent the number of numbers prime to m, and not surpassing m: the equality

$$\Sigma \pm (1, 1)(2, 2) \ldots (m, m) = \psi(1)\psi(2) \ldots$$

was established in the note, and several consequences deduced from it.

Zoological Society, May 16.—Dr. A. Gunther, F.R.S., vice-president, in the chair.—Dr. P. Comrie exhibited and made remarks on the zoological specimens collected by him during the survey of the south-eastern coast of New Guinea by H.M.S. *Basilisk*.—Dr. Gunther exhibited and made remarks on a collection of Mammals from the coast of Borneo, opposite to Labuan. Among these were especially noticed a young example of a Monkey (*Macacus melanotis*) of which the exact habitat was previously unknown, and a new species of *Tupaia*, proposed to be called *T. minor*.—Dr. Gunther also read an extract from a letter recently received from Commander Cookson, R.N., stating that he was bringing home from the Galapagos Islands a living pair of the large Land-tortoise, of Albemarle Island. Commander Cookson stated that the male of this pair weighed 270 lbs., the female 117 lbs.—Mr. Sclater exhibited the skin of a rare Pacific Parrot (*Coriphilus kuhli*), which had been obtained by Dr. T. Hale Streets, U.S. Navy, at Washington Island, of the Palmyra group, and had been sent to him for examination

THURSDAY, JUNE 8, 1876

ON THE ORGANISATION OF THE PROFESSION OF CHEMISTRY

IT has probably happened to many young men who have fallen within the attraction of chemistry at the Universities or elsewhere to receive from their elders the prudent warning—chemistry is not a profession. Nor has this warning, or the fact conveyed in it, been without influence upon the number of chemical students. The complaint is often heard that original research in chemistry is at a low ebb in England at the present time. Comparatively few have both inclination and income enough to pursue chemistry as a scientific study without making it also in some way a means of livelihood. Contributions to biology come chiefly from members of the medical profession, contributions to mechanical science from engineers, contributions to chemistry from those who make a living by teaching or practising chemistry, and in proportion as a knowledge of this science opens a career, and is recognised as the basis of a profession will a twofold gain accrue. The character and attainment and number of those engaged in educational or practical chemistry will be raised, and as a consequence the quality and number of the contributions made to scientific chemistry will increase also.

At the present time there is a considerable and an increasing demand for young men having a knowledge of chemistry, as teachers, as laboratory assistants, as analysts or experimentalists on chemical and other work. But, partly because the importance of chemistry has not long been recognised, partly perhaps for want of organisation, to be a chemist does not constitute a definite vocation which a young man of the professional classes may choose with the same confidence as to be a doctor or a lawyer.

A vigorous attempt is now being made to organise an Association, or Guild, or Institute of Chemists, membership of which should confer a professional status and imply fitness for duties requiring chemical knowledge and experience.

Under the Act of Parliament for the prevention of adulteration of food and drink, and of drugs, passed in 1872, a number of persons have been appointed in all parts of the country as analysts. It must frequently have been a difficult task to find "persons possessing competent medical, chemical, and microscopical knowledge" to fill these posts. Where those with whom the appointment lay took pains to assure themselves of the fitness of their nominee, probably as good appointments were made as if professional chemists already formed a well defined class. But a definition and separation of qualified chemists, such as membership of the proposed Institute might effect, would serve as a guide to those charged with the duty of making such appointments, and would be a barrier against the nomination of wholly unfit persons.

On the other hand, it is worth remarking that the existence of a technical qualification is sometimes unfavourable to the selection of the best out of several candidates who possess it. The friends of an inferior candidate are apt to believe that all who possess the qualification are capable of doing the required work properly, and that the particular choice may fairly be determined by other considerations.

Employment of an unofficial kind, it may be thought, is not likely to be given to incompetent persons, since the employer has an immediate personal interest in being well served. But here also the existence of a distinct qualification, such as a licence to practise as chemist, granted after examination by an authorised body, would aid the choice of the employer, and would increase the chance of employment to those properly qualified.

The duties which fall to the lot of men engaged in general chemical practice are perhaps less important than those which are discharged by medical practitioners, and the persons who consult or employ chemists are, as a rule, more capable of selecting a qualified practitioner than the general public. The need of a professional stamp is therefore much less than in medicine. With this limitation, the same reasons which have led to the establishment of a legal distinction between the doctor holding a diploma and the quack doctor, would seem to favour the establishment of a similar distinction between the professional chemist and the amateur.

At a meeting held recently in the apartments of the Chemical Society at Burlington House, which was attended by a large number of the leading members of the Chemical Society, it was unanimously resolved that it is desirable that an organisation of professional chemists should be effected, and that for this purpose a body should be formed, having authority to issue certificates of competence. The questions which next arose, as to the nature of the organisation, and as to the steps by which it might obtain legal recognition, led to the consideration of the advantages or disadvantages of connecting the proposed organisation with the Chemical Society.

This Society includes among its Fellows the most prominent and by far the greatest number of those who are following chemistry as a profession. It has also the advantage of long standing, having been founded in 1841, of an established position, and last but not least, of incorporation by Royal Charter. Probably the existence of the Chemical Society might hinder the granting of a Charter of Incorporation to the proposed Institute. It is therefore clear that if the Chemical Society could undertake to issue licences to practise in chemistry, or certificates of competency, it occupies in some respects an advantageous position for doing so.

Nor does it appear that such an undertaking would exceed the wide discretion which is granted to the Society by its charter. The objects of the Society were defined by its founders to be "the promotion of chemistry and of those branches of science immediately connected with it, by the reading, discussion, and subsequent publication, of original communications." Here we breathe the upper air of pure science, of knowledge for its own sake. But the objects which the Charter recites are—"The general advancement of chemical science, as intimately connected with the prosperity of the manufactures of the United Kingdom, many of which mainly depend on the application of chemical principles and discoveries for their beneficial development, and for a more extended and economical application of the industrial resources and sanatory

condition of the community." The Charter proceeds to constitute the Fellows of the Society one body politic and corporate, and empowers a General Meeting of the Fellows, *inter alia*, to "enter into any resolution and make any regulation respecting any of the affairs and concerns of the said body politic and corporate that shall be thought necessary and proper."

It has been urged that it would be difficult to make a distinction between ordinary Fellows of the Chemical Society and qualified practitioners admitted and registered through the agency of that Society. This difficulty lies chiefly in the choice of an appropriate name. "Licensed Fellow" has an awkward sound, and "Licentiate" is, by analogy, a lower title than "Fellow." There seems to be nothing in the Charter to forbid such a distinction, which would be for external use only, and would not differentiate the holders of licenses in respect of eligibility to Council or any other privilege, from ordinary Fellows of the Society. Indeed it does not appear that it would be *ultra vires* for the Chemical Society to grant certificates of competency as Chemists to those who are not Fellows of the Society.

Leaving, however, the question of what is legally practicable, we must confess that in spite of our sympathy with the proposed organisation, we doubt the expediency of effecting it through the instrumentality of a society which has hitherto occupied itself solely with the extension and diffusion of knowledge.

The first granting of licences would be presumably to those who have already an established position as practical chemists. The task of selection would be invidious, and would involve a responsibility from which the Chemical Society would naturally shrink. Subsequently, we presume, licences would be granted upon an examination, and it would seem to be a wide departure from the functions which the Chemical Society has hitherto performed, for it to constitute itself an examining body, or to undertake the appointment of a Board of Examiners.

If no other plan were practicable we might hesitate to express our dislike to the proposal that the Chemical Society should enter upon this new career. Existing examining bodies and bodies that issue certificates to those who pass their examinations, are ready to hand. It should not be difficult to obtain the co-operation of the Universities in this matter, and a Board of Examiners appointed by the Universities of Oxford, Cambridge, and London, without necessarily any restriction that those applicants should have received a University degree, would probably command and deserve confidence better than a Board nominated by a newly formed Institute or even by the Chemical Society.

At least such a scheme might serve at the outset; and when through its operation chemistry had begun to be consolidated and recognised as a profession, the proposed Institute of Professional Chemists might be formed, and undertake for the future the selection of its own members.

THE ENDOWMENT OF RESEARCH

Essays on the Endowment of Research. By Various Writers. (London: King and Co. 1876.)

IT is to the untiring exertions of Dr. Appleton in the cause which is here pleaded, that we are indebted for this valuable combination of essays. The eminence and competency of the writers give it an overwhelming force of authority and reason. The list of contributors is as follows:—The Rector of Lincoln College, Oxford, Mr. James Cotton, late Fellow of Queen's College, Dr. Appleton, Fellow of St. John's College, Mr. Sayce, Fellow of Queen's College, Mr. Henry Sorby, F.R.S., President of the Microscopical Society, Mr. Cheyne, Fellow of Balliol, one of the company for the revision of the Bible, Mr. Thiselton Dyer, late of Christ Church, Assistant Director of the Royal Gardens, Kew, Mr. Nettleship, Fellow of Corpus Christi College. These eight writers treat of various aspects of the Endowment of Research, such as the need for it, the applicability of college revenues to the purpose, the incompatibility of teaching and research in ten essays. No doubt more remains to be written on the subject, more will have to be said, and what is said will need to be said a great many times before the public—even its more intelligent section—comprehend the importance of research or the necessity for its endowment. The present volume may be taken as a fair statement of some of the most important arguments in the matter, and should furnish the starting point for a determined and unwearying effort *permanently* to affect public opinion in the right direction. Widely as we should wish to see this book read amongst the laymen of science, the Philistines and those who prophesy to them, politicians and professional reformers, it will certainly be found quite as valuable as by any of these, by men of science. Men of science will find in the present volume data and suggestions which should aid them greatly at this critical moment to determine what they will urge upon the government, as the true relationship between the State and scientific research.

The substance of these essays may be summarised in the form of a series of questions and answers, the latter being frequently reiterated, as it were, by one after another of the essayists.

1. What is this "research" which you propose to endow? It is more fully described as "scientific research." It is the "disinterested pursuit of knowledge" (Pattison), the following up of "science for science sake" (Pattison), and "by the introduction of the utilitarian motive its strictly scientific character is destroyed" (Appleton). It is co-extensive with the whole range of human knowledge, and comprises such groups as "historical science," "mental science," "linguistic" science, (Sayce, Cheyne, Appleton), equally with molar and molecular physics, astronomy, geology and biology. It has its end and aim in itself, viz., the attainment of truth. We assume that it is necessary for man, necessary for his progress, for his happiness if you please, but inevitable whether for weal or for woe, predestined by the noblest and most commanding passion of his nature—*the love of the truth*. To the ignorant or unthinking some truths appear to justify this craving on account of the material gratification which their knowledge enables mankind to obtain, whilst the acquirement of other truths appears to these persons superfluous. A consideration of any one department of knowledge is, however, sufficient to show us "that nature is one, and that no man dare put his finger on any of its secrets and say this is a mere field for ingenious curiosity" (Dyer). The narrower type of utilitarian, with his petty measure of what is and what is not for the happiness of mankind,

has no scope for discussion in this matter; he must bow before the inexorable domination of an impulse planted in the very elements of our being. The importance to the community of mature study and scientific research has been recognised in the past both in our own and other countries; at the present day it is very much less appreciated in England than elsewhere. The immense fields which lie open to us, with their harvest of knowledge waiting for reapers, are to some extent indicated in the essays by Mr. Dyer, "On the Needs of Biology," Mr. Cheyne, "On the Study of the Bible," of Mr. Sayce, "On the Needs of the Historical Sciences." Over and over again it will be necessary to explain, as these essays do, how great and of what kind are the stores of knowledge which students see within their grasp, and how difficult and all-absorbing is the task of reaching them. It is the duty of men of science incessantly to exert themselves in inducing the great public, even though this generation and its successor prove stiff-necked and hardened in heart, to believe their report of the promised land.

2. Granting that "scientific research" is a good thing and to be wished for as the highest development of the life of the community, why should it be endowed? Why should persons be supported by public funds to carry on research? Why not leave every man to follow research for his own delectation, and trust to the attractions which it possesses for its increased cultivation?

Because it cannot be successfully carried on, in the present conditions of society, by men who have to earn their bread in any of the usual avocations. Mr. Sorby, in his "Personal Experience" (Essay No. VI.), with convincing simplicity and candour, tells us how all absorbing is research, how much may be lost by withdrawing the man who is engaged in an investigation, even intermittently, from his pursuit, how necessary is ample time, freedom from anxiety, health of body, "readiness of the mind to take advantage of every circumstance that may occur to press forward the inquiry in the line of truth." Fortunately Mr. Sorby is endowed with a patrimony, and he says, "I never could have done what I have been able to do if it had been necessary for me to attend to any business or profession as a means of support." Men who are capable of or disposed to engage in scientific research are not always thus situated. Unless we are prepared to lose the services which these persons might render--some of them perhaps the very ablest and most productive minds--and to rest our hopes on the chance coincidence of fortune and ability, as for instance in the cases of Lyell, Darwin, and Grote, we must accept a scheme for providing such persons with pecuniary support out of public funds. To a certain extent we already do this, but very inadequately. The posts in the British Museum, the Greenwich Observatory, and a few others here and there, are of the nature of endowments for research. But these are so few in number and so meanly paid that they cannot be regarded as exercising any important influence in attracting men of ability into the career of research. Among Continental nations but especially in the German empire, in proportion to the wealth of the countries in question, very much larger provision is made for the encouragement of research--and with the most perfect success, as tested by results. In Germany, owing to the special view which is taken in that country of a "University," there are 1,250 posts designed for the promotion of research with stipends varying in value from 80*l.* to 600*l.* a year. There is one such post to every 33,000 of the entire population, or to every 1,600 males between the ages of twenty and thirty years. The total cost of the support of these persons and the laboratories, libraries, &c., with which they are connected (leaving out of consideration such special institutions as are the exact counterparts of our British Museum, observatory, &c.) cannot be less than 600,000*l.* annually. An equivalent provision in England would necessitate the creation of 1,000 posts at an annual expense of 800,000*l.*, making allowance for the fact that money has at least double the value in Germany which it possesses in England, in relation to the purpose under consideration. It is curious to observe that this sum (800,000*l.*) corresponds very closely with the estimated value of the incomes of the ancient University institutions of Oxford and Cambridge—where, however, the money is not applied to the endowment of research.

3. The reference to Universities and to Oxford and Cambridge brings to mind a suggestion which at first sight appears admirable. "Granted that research must be endowed, there is yet great difficulty in persuading practical men to pay for it in the pure and unalloyed form. It can only be a pleasure to the investigator to communicate to pupils the results which he obtains in his researches, clearly it is his natural function to teach. In fact you have already got what you want in the Fellowships of Oxford and Cambridge, many of the holders of which reside in those Universities and teach and doubtless spend a large portion of their time in research. Abolish the non resident Fellowships, remove the immoral condition of celibacy, give two or three Fellowships to the men who stay longest in the place, require them all to teach at a cheap rate (this will be well received by the public) and you may be sure that they will devote all needful energy to original research. Is not your demand for the endowment of research liberally met in this way?" Certainly not.

The deadly error embodied in the above bids fair at the present moment to destroy the good hope which we at one time possessed of seeing at Oxford at any rate (it is from Cambridge that the mischief has come) a portion of collegiate endowments applied to the support of research. The chief care of the Oxford men who write in Dr. Appleton's volume is to combat the insidious doctrine that *research* is compatible with *teaching*, in the narrow sense in which teaching is understood in Universities which like Oxford and Cambridge are carried on upon the plan originated by and worthy of the Jesuits (see Pattison, Essay No. 1), viz., that in which competition by examination for prizes forms the pivot of all activity. The watchwords of the German Universities "Lehrfreiheit" and "Lernfreiheit," are (save to a very few) unknown, the idea which they express equally so, in this country.

The suggestion that teaching and research should go hand in hand appears at first sight admirable, because there can be no doubt that in the wider and higher sense of the word "teaching," the investigator is and must be a teacher. In the German Universities it is a small tax upon the professor or holder of a research endowment to give a course of lectures upon the subject with the study

of which he is occupied. He is entirely free from the influence of the Jesuit's examination system; that has been long since abolished (where it existed) in German Universities. He is never concerned for one moment with the thought as to what place his hearers may take in an examination—such examination as there is being entirely in his own hands—and having very little importance attached to it. Moreover, he cannot (at any rate in the early part of his career) make anything considerable by the fees of his hearers, and has to look for his promotion and increase of income solely to *success in the occu-* [illegible] *which his chair assigns to him, namely, original research.*

The preparation of students for an examination by the results of which they are to gain or fail to gain valuable money-rewards, is a business by itself; and the man appointed to carry on this business, especially when his own income and his promotion depend upon his success in placing his pupils well in the examination, cannot pay much attention to other things. He is in a totally different position from that of the German professor. He is in the position which Mr. Sorby deprecates, viz., that of having an anxious commercial pursuit. But, worse still, as Mr. Pattison and Mr. Nettleship point out in their essays, he deals with knowledge and the results of study in such a way (viz., for examination purposes) that he necessarily is liable to become less fitted than any other man of business to pursue knowledge for its own sake. He and his pupils take up a radically false position with relation to knowledge.

The essays of Mr. Pattison and Mr. Cotton are particularly interesting as showing how the present enormous revenues of the Colleges and Universities of Oxford and Cambridge came to be employed, as they are for the most part, in the cheapening of cramming (as Mr. Sayce does not hesitate to call it) and the reward of success in being crammed, or in the subvention of resident college-lecturers and tutors on the one hand, and non-resident competition prize-men on the other. Originally this was not the case; Fellowships were even founded for the express purpose of relieving their holders from the distraction of teaching, in order that they might devote themselves to study. It was unfortunately at a time when the Church was entering upon a new phase of its history, no longer to be the great representative of learning and science, but something very different, that Leicester and Laud handed over the University to the Colleges and the Colleges to the Church. The Fellowships became so much capital, by means of which, in virtue of their monopoly of education, the Colleges were able to convert themselves into what they have with general approval, but to the detriment of science and letters, become—proprietary schools[1] for the "finishing" of young gentlemen. Under the present system the resident Fellow doubles his income through the division of the monopolised fees, whilst the young gentleman's parents pay half[2] what they would have to pay elsewhere for the same amount of constant supervision, cramming, and "direction."

Whatever portion of the collegiate revenues is retained by the new University Commissioners for the College tutors, or as the Oxford Hebdomadal Council has expressed it, for "education" (as that word is understood at the English Universities) is clearly enough lost to research. This proposition is perhaps the main result of the arguments adduced in the essays of the rector of Lincoln, Dr. Appleton, Mr. Sayce, and Mr. Nettleship.

4. All this being admitted, namely, that it is a matter of urgent importance to provide an extensive series of fairly-remunerated posts to be held by persons constantly engaged in research, unencumbered even by the plausible condition of preparing young men for examination, the practical questions come—which with Englishmen are generally the first questions—namely, Whence is the money to be obtained for this purpose, and how are you to ensure that true "research-men" will get the posts supposing that they are once created?

These are two distinct questions. As to the first the answer is simple. It is only through the direct intervention of the Government that the thing can be done. Government may assign for this purpose a large part of the revenues of Oxford and Cambridge, of City Companies, or of the Irish Church; or the sum required may be met annually by the taxes. The "Essays" have chiefly in view, no doubt, the appropriation of a part of the revenues of Oxford and Cambridge to this purpose. At the same time we must remember that even were some 200,000*l.* a-year detached from those institutions and deliberately and simply assigned to the promotion of research under State control, yet even then only a portion of the national requirements would be met. A larger sum than this is needed to carry out even a moderate scheme. When, however, it is proposed to leave the 200,000*l.* a year under the control of its present administrators with general directions to them to employ it in the encouragement of research, we must contend that there is very strong reason, indeed, for an additional altogether independent and strictly national endowment of research—such as has been hinted at by Lord Derby—and such as is carried out by continental Governments.

The second question as to the means to be adopted in order to avoid jobbery and sinecurism in connection with the proposed series of posts, is not discussed in any way in the volume under review. It is, however, one of the most serious questions, and we shall therefore venture very briefly to furnish an answer which is, as far as we can see, completely satisfactory. In a question like this, of serious practical importance, the most conclusive answer is to be found in an existing solution of similar difficulties in a very closely similar case.

This we possess in the great German University system. Whatever objections Englishmen may have to German Universities as teaching bodies, the fact remains that as an arrangement for the endowment of research on a truly national scale they are the most unqualified success. Research *is* endowed by this system and *is* abundantly carried on, and this without (to the writer's knowledge) a suggestion or imputation of jobbery or sinecurism in connection with it.

The elements of this success in the German system are the following:—1. The appointments are held by twenty-one groups of men engaged in research. 2. By custom and the conditions of society (legislative prohibition would

[1] See Prof. Max Müller in the *Academy*, May 11.

[2] The Oxford undergraduate pays on an average 20*l.* a year for being prepared for examination. A well-known "grinder" for the Indian Civil Service examinations charges, I believe, 100*l.* a year for similar preparation.

have to be called into use in England) these corporations are not allowed to make money by engaging in commercial pursuits or the keeping of boarding-schools. (3) The appointments are graduated in value from 80*l.* to 400*l.* per annum. (4) New members are chosen in any one corporation by co-optation. The promotion of existing members is effected by the same process—one corporation often inviting a member of another to leave his old associates in order to enjoy an increased salary, or increased facilities for research. This co-optation is carefully supervised but not directed by the State Government. (5) Since commercial operations, such as the acquirement of a large revenue by any corporation from the fees of pupils or wards committed to its care, are out of the possibilities of the case—the sole motive which affects the various corporations in their choice of colleagues is a desire to secure colleagues of eminence in the avocation which is assigned to the corporations, namely, research, and in this way to maintain a high reputation for the corporation and congenial association for its members. (6) The result of this is, that the whole stimulus which the prospect of a step-by-step accession of income from 80*l.* to 400*l.* or 600*l.* per annum can bring to bear upon the nature of man is constantly at work in urging those who enter upon this career to give their full energies to research, and research alone. The habit of research so stimulated and fostered, remains even after a career of twenty or twenty-five years—the length of service which entitles the German professor to retire upon full pension.

The enormous fertility of Germany in all kinds of research is the outcome of this simple and healthy system. There does not appear to be any reason why a parallel system applied in this country should not produce parallel results. E. RAY LANKESTER

QUAIN'S ANATOMY

Quain's Elements of Anatomy. Eighth edition, edited by Dr. Sharpey, Dr. Allan Thomson, and Mr. E. A. Schäfer. Two Vols. (Longmans, Green and Co., 1876.)

THE seventh edition of Quain's "Anatomy" appeared nine years ago under the conjoint editorship of Dr. Sharpey, Dr. Thomson, and Dr. Cleland; in the eighth Mr. E. A. Schäfer's name is found on the title page instead of that of the last-named anatomist. The new edition contains much new matter, and with a larger as well as a clearer type, covers nearly an extra hundred and sixty pages.

The arrangement of the subject-matter is considerably modified in the direction of improvement; the descriptive account of the bones, joints, muscles, vessels, and nerves, together with the surgical anatomy, occupying the first volume; the second, containing the general anatomy or histology, the structure of the different viscera, the organs of special sense, and the embryology.

A much-needed advance has been made in the sections devoted to osteology and myology, which consists in the introduction of paragraphs on general morphology. Teachers of anatomy are too apt to entirely neglect those great strides that have been made in zoology, many of which have an important bearing upon the way in which the human skeleton and soft parts should most certainly be regarded. We, upon this view of the question, are therefore glad to find among other innovations, a classified list of the bones of the head, and their typical component parts, the nomenclature adopted being that employed by comparative anatomists.

The introduction of nitrate of silver, osmic and chromic acids, logwood, &c., as adjuncts to histological manipulation, as well as the efforts of many able investigators, have rendered corresponding changes necessary in the sections of the work devoted to the microscopic structure of the tissues and organs; and Mr. Schafer has here introduced several fresh illustrations, and much new matter, which makes the "general anatomy" by itself an invaluable summary of the most modern aspect of histology. The development of blood corpuscles, the ground-substance of connective tissue, the ultimate nature of muscle, the serous membranes and their lymphatics, have received the greatest additions in this portion of the work.

Dr. Allen Thomson has entirely re-written the chapter on embryology, having embodied all the more recent results in this rapidly advancing department of biological science, arrived at by Foster and Balfour, Parker, Mihalkovics, Waldeyer, and others. The whole forms a most excellent account of human embryology, as far as it can be known from the incomplete direct, and the much indirect evidence which can be brought to bear upon it.

The editors acknowledge the assistance of Dr. Gowers, Assistant-Physician to University College, in the revision of the paragraphs on the Cranial Nerves; and in the chapter on the Brain and Spinal Cord, Dr. Gowers has introduced a valuable account of the cerebral convolutions, together with some excellent drawings, more elaborate than those of Ecker. The nature of the many layers of the cerebral cortex is fully discussed, at the same time that a careful abstract of the terminology of Meynert is given, with additional figures.

There is one minor zoological error which we have not seen corrected in any anatomical or physiological textbooks. It is in the nomenclature of the animals with peculiarly small blood-discs. The "Napu Musk Deer" is said to possess the smallest blood corpuscles of all mammalia. It is now known that the Musk Deer has no special kindredship with the Chevrotains, or Tragulidæ, to which group the Javan Chevrotain (*Tragulus javanicus*), which formerly went by the name of the "Napu Musk Deer," belongs. A reference to Mr. Gulliver's more recent paper[1] also shows that in the Indian Chevrotain (*Tragulus meminna*) the discs are equally minute.

With reference to the typography we think it much improved in all respects, but of the figures we cannot help remarking that sufficient care has not been taken by the printers in doing justice to the artists or the engravers. Several of the older woodcuts are, no doubt, much worn, but they, as well as the more recent ones, are printed much too black, considerably darker than in the previous edition.

OUR BOOK SHELF

Exercises in Electrical and Magnetic Measurement. By R. E. Day, M.A. (London: Longmans, Green, and Co., 1876.)

MR. DAY'S little book on Electrical and Magnetic Measurement seems to us likely to be of considerable

[1] Proc. Zoolog. Soc., 1875, p. 49.

service both to teachers and to students. The best proof of knowledge of any branch of physics, and the most practical result of the study of any such branch is the acquisition of the power of applying numerical calculation to every question where a numerical result can be obtained. The student knows that he understands a subject thoroughly when he can write down numbers to express definitely the amount of every effect observed and measured by experiment. The importance of numerical calculations in absolute measure is becoming daily more and more appreciated: and in the best English text-books numbers expressing quantities in absolute measure are now to be found, instead of the relative numbers that were alone obtainable from the text-books of only a few years ago. Mr. Day's book brings very fairly together such questions as are likely to present themselves to the student of electricity and magnetism. Anyone who has acquired sufficient knowledge to work through a considerable part of the exercises cannot fail to find them extremely useful.

We have observed some slips that ought to be corrected in future editions. Among them may be mentioned some of his exercises on the tangent galvanometer. No practical experimenter would think of using the tangent galvanometer in such a way as to bring the deflection to 89° 30′, as Mr. Day does in Ex. 23, p. 47, or to the high numbers that he refers to elsewhere. We find readings of Thomson's reflecting galvanometer given in degrees, minutes, and seconds. This seems rather absurd, to say the least of it. In a few of the exercises, as in Ex. 9, p. 33, the data are insufficient.

A few more definitions would, we think, be found useful. Some of the terms employed are uncommon, and some appear to be used somewhat ambiguously. Thus in Ex. 2, p. 17, the word *density* is wrongly used for quantity. Again *density* of an electric current is a term so unusual that some explanations regarding it seem all but necessary. The definition, given in Ex. 2, p. 72, as Bunsen's definition, appears a very incomplete one. According to it, a *current of unit density is a current of unit strength passing through a voltameter between two electrodes each one square millimetre in diameter*, and from this it would follow, we presume, that the so called density of the current is the same at every part of the voltameter and independent of the form of the voltameter. If so we cannot think of any possible use of such a name. The terms Farad and Weber, given by some of the practical electricians seem to be used indifferently in more senses than one. It is simply unpardonable, in the present state of the science, to *introduce* ambiguities of language.

On the whole, however, we are much pleased with Mr. Day's little book, and can warmly recommend it both to teachers and to those who are studying electricity and magnetism without the aid of a teacher.

Geological Survey of Victoria. Prodromus of the Palæontology of Victoria. Decade 3. By Frederick McCoy. (Melbourne. London: Trubner and Co., 1876.)

WE are glad to find that in spite of the unpromising news which has recently reached England concerning the present condition of the Geological Survey of Victoria, the palæontological work, which is in the hands of such a well-tried and indefatigable naturalist as Prof. McCoy, continues to make satisfactory progress. The present decade of the *Prodromus* is of more than local interest, containing as it does interesting new details concerning Owen's marsupial lion, the *Thylacoleo carnifex*. The result of Prof. McCoy's examination of more perfect specimens than those on which the first description species was based, is to suggest modifications in some of the views published by Prof. Owen, but to add confirmation to that author's main position concerning the carnivorous habits of the animal, a conclusion which was called in question by Dr. Falconer and Prof. Flower. Scarcely less interesting at the present time is the illustration and description of a species belonging to the sub-genus of *Nautilus*, known as *Aturia*. A similar form has been found by Dr. Hector in New Zealand, but in rocks of far older date, and the facts which have already come to light concerning the distribution in space and time of this remarkable genus are such as to invest it with the very highest interest both to the geologist and biologist.

On similar grounds the new species of Tertiary *Trigonia* and *Pleurotomaria* genera which were so abundant during earlier periods of the earth's history, but which, except in Australia, appear to have become almost wholly extinct at the close of the Mesozoic epoch—are especially worthy of the attention of the palæontologist. The other new forms illustrated in this decade, including a number of Trilobites and Tertiary Mollusca, do not call for any special remark. Prof. McCoy's scientific descriptions are admirably clear and exact, and his general remarks on the relationships and distribution of the species very valuable and suggestive. The engraving and printing of these decades afford evidence alike of the progress made by our Australian colonies and the liberality with which scientific research is supported in them. The plan of publication by decades, illustrating the palæontology of the countries geologically surveyed, was commenced in the United Kingdom by Sir Henry de la Beche, and has been followed both in Canada and India. The decades of the Victoria Survey are quite worthy to take rank, both as regards matter and form, with those of either of the older surveys we have mentioned; and higher praise than this it would scarcely be possible to add.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Scientific Poisoning

FOR giving instruction to *one person* in the art of poisoning without detection, the medical student, Vance, is undergoing the very lenient punishment of eighteen months' imprisonment. What would be the appropriate penalty to inflict upon the responsible editors of newspapers who initiate *the public generally* into Vance's secret?

CHEMIST

Pyrology—Quantitative Analysis by the Blowpipe

THE *estimation* of constituents in compounds by the blowpipe has been hitherto, as is well known, limited to the process of metallic (or, in the case of cobalt, arsenidal) reduction of oxides, &c., and that with regard to a very few metals only. I now propose to inaugurate a new plan, by which this rapid, elegant, and accurate method of analysis may (apparently) be applied far more generally, and, as I hope, successfully. In my published work "Pyrology, or Fire Chemistry," I have, with the exception of a few indications (as in the case of the insoluble balls formed by *lime* in *boric acid*), confined myself to qualitative research only, but many methods will suggest themselves to the attentive student of that book, by which qualitative may be readily extended to quantitative examination.

I propose to proceed more in the direction of a kind of *volumetric analysis* than of analysis by means of the successive *separation* of constituents, as in the "wet way," and I trust that the consideration usually accorded to novelty and the difficulties always inseparable from useful novelties will not now be refused by scientific Englishmen to my feeble initiatory researches, especially as I am (I believe) the first Englishman who has published much *original* matter on this subject. It seems likely that the operator who can, by reason of the *rapidity* of his methods, obtain the *mean of a number* of approximate analyses of a particular substance in the same or less time than that required by the employer of an abstractedly more correct but practically more

dangerous mode (from the failure of any one of the delicate manipulations introduced) for *one analysis*, will probably arrive in the end, at a result more closely approaching to the truth.

Blowpipe Assay of Ores, Furnace Products, &c., for COBALT.

1. The *rationale* of this process depends upon the observations (*a*), that a trace (say ·5 mgr.) of cobalt oxide affords, when dissolved in a bead of microcosmic salt, *the same* colour (violetish blue) which is afforded by the addition to a similar bead of *five times* as much oxide, or 2·5 mgrs.; and (*b*) that these relative quantities of cobalt oxide afford, when dissolved in *phosphoric acid* beads of the same weight (say 60 mgrs.), *perfectly different* colours; viz., *pink* as regards the smaller proportion, *violet* as regards the greater.

2. The corollary derivable from these premises seemed to me, therefore, that, the quantity of phosphoric acid being kept constant, it would require the addition of more *soda* to turn the pink bead than the violet bead *blue*; first, because violet already contains blue, and second, because the cobalt might be presumed to have already saturated, as a chemical base, part of the phosphoric acid.

3. I was *exactly wrong* in this assumption. Different quantities of soda were, indeed, required to azurise the two beads, but the *violet* bead required *more* than the pink one.

4. Without troubling the reader with tedious details, I may state here that each of three assays constantly showed the necessity of an addition of 14 mgrs. of fused sodium carbonate in order to azurise a 60-mgrs. bead of phosphoric acid, made pink by the solution in it of ·5 mgr. of pure cobalt oxide; and (by three other assays) an addition of 20 mgrs. of soda to azurise a 60 mgrs. bead made violet by 3·5 mgrs. of cobalt oxide. The ratio, therefore, stood thus:—

$$\begin{matrix} \dddot{\text{NaC}} & & \dddot{\text{NaC}} & & \text{CoO} & & \text{CoO} \\ 20 & : & 14 & :: & 3\cdot5 & : & \cdot5 \end{matrix}$$

or the violet standard of cobalt was to the pink standard, as 2·45 : 0·71. It would, by these assays, seem that every half milligramme between those extremes of cobalt oxide dissolved, requires the addition to the bead of one milligramme of fused sodium carbonate, in order to azurise a 60 mgrs. bead of pure phosphoric acid.

5. The way to operate is to compare, by reflected and transmitted light, the blue colour thus obtained, with that of two 60 mgrs. beads of *micro osmic salt*, having the above-named quantities of pure cobalt oxide respectively dissolved in them. Space does not allow me here to describe the *mechanical details* of operations, which must be conducted with the utmost care.

6. From these facts, the following analytical table, as regards *cobalt*, is deduced:—

CoO mgrs.		$NaCO_3$ mgrs.				
0·5	requires	14	=	0·83	per cent. of a 60 mgrs. phosphoric acid bead.	
1·0	,,	15	=	1·6	,, ,,	,,
1·5	,,	16	=	2·5	,, ,,	,,
2·0	,,	17	=	3·3	,, ,,	,,
2·5	,,	18	=	4·1	,, ,,	,,
3·0	,,	19	=	5·0	,, ,,	,,
3·5	,,	20	=	5·8	,, ,,	,,

The use of this table is shown in the following example:—

7. *Assay* (*for Cobalt only*) *of Smaltine, from a Freiberg Cabinet.*

			mgrs.	per cent.
α.	Weight of powdered ore crushed between agates	=	50	—
β.	Weight of powdered ore after roasting on aluminium plate...		18	36
	Therefore the loss in arsenic and volatile constituents	=	32	64
γ.	Weight of a new platinum wire with a ring of 1 diameter[1]	=	71·5	—
δ.	Weight of the same platinum wire with a bead of phosphoric acid fused on it	=	134·5	—
ε.	Weight of the bead and wire after 2·5 mgrs. of (β) had been dissolved in the former	=	124·0	—
ζ.	Weight of the bead and wire after the addition of fresh phosphoric acid[1]	=	132·5	—

[1] This refers to the "ringing forceps."

(This bead being *rose* colour,[2] *fused sodium carbonate* was cautiously taken up from an agate slab and dissolved in it under **O.P.**).

			mgrs.	per cent.
η.	Weight of soda required to colour to the *blue* of mic. salt with 2·5 CoO .		16·5	—

Now, by the above table (6), 16·5 mgrs. of *soda* correspond to 3 per cent. of a 60 mgrs. bead in *pure* CoO; and 2·5 mgrs. of pure CoO, requiring 18 mgrs. of soda, constitute 4·1 per cent. of the bead. Therefore we have the ratio—

$$4\cdot1 \ : \ 3 \ :: \ 100 = \tfrac{3}{4\cdot1}\text{ths of } 100 = 75 \text{ per cent.}$$

But, as this is the percentage of the *roasted powder*, or "regulus," we have—

Regulus in 100 mgrs.		Percentage of regulus. mgrs		Mgrs. of ore.	
36	:	75	::	100	= 20·08 per cent. cobalt.

Several assays were made with a similar result, but one other example is given here, with a different platinum wire.

				mgrs
α.	Weight of a platinum wire		=	61·0
β.	,,	ditto with bead of phosphoric acid	=	131·0
γ.	,,	roasted *smaltine* dissolved in (β).	=	2·5
δ.	,,	this wire with bead coloured rose pink with (γ)	=	118·5
ε.	,,	bead and wire with fresh phosphoric acid	=	121·0
ζ.	,,	sodium carbonate required to colour (ε) *blue*		16·5

8. These data would, of course, give a similar result. Roasting before O.P. on *aluminium plate* is so rapid and efficacious that the whole process only occupies about half an hour; with the *roasted powder*, about a quarter of an hour. A drop of water is placed on the powder to retain it under the blast.

In roasting, *nickel* oxide appears, yellowish green, on the surface, and might possibly be mechanically separated at this stage of the procedure.

W. A. R[illegible]

[1] This is necessary to make up the weight of the bead to 60 mgrs After the addition of soda, there is *no* loss from volatilisation.

[2] From the interference of iron and nickel oxides in the assay

Page's Introductory Text-book of Physical Geography

It has been pointed out to me that the same errors which I noted in this book (NATURE, vol. xiv. p. 26), had been corrected as regards Prof. Page's "Advanced Text-book" by Mr. Wallace three years ago. They can scarcely, therefore, be anything but wilful, and it is difficult to understand how they could be allowed to reappear. We do expect teachers of position at least to do their best to teach rightly; and when one has fallen into error it is certainly more manly to correct it than to stick to it, because it has once been committed. It is a good thing to teach science, but it is just the opposite deliberately to teach false science.

THE REVIEWER

OUR ASTRONOMICAL COLUMN

THE SECONDARY LIGHT OF VENUS.—By way of supplement to the historical notes on the luminosity of the "dark side" of the planet Venus in last week's "Astronomical Column," a brief enumeration of the various explanations of the phenomenon which have been offered from time to time may not be out of place here.

These resolve themselves into (1) reflected earth-light analogous to the lumière-cendrée exhibited by our moon, an explanation advanced by Schröter, Harding, and many others; (2) phosphorescence of the planet's atmosphere, suggested by Sir W. Herschel to account for the appearances remarked by Schröter, though looked for without success by himself, with which may be mentioned Pastorff's idea of a self-luminous atmosphere; (3) visibility by contrast—"might not a plausible explanation be given," asks Arago, "by referring it to a class of objects which are negatively visible, or which are rendered apparent by way of contrast?" (4) luminosity, similar to our polar-light (aurora borealis); (5) natural light-developments, as luminosity of the ocean; (6) a condition of

glowing fire, or intense heat of the surface, and (7) the *Künstliche Feuer* of Gruithuisen

There is one characteristic of the phenomenon abundantly verified by the numerous observers who have recorded it, which cannot be overlooked in our endeavours to arrive at its true cause, viz, its intermittent or only occasional visibility This alone appears to render more than one of the explanations which have been advanced highly improbable if not wholly inadmissible. There are also isolated observations which seem rather to favour one or other of the hypotheses Thus Schroter considered that the change in the colour of the faintly illuminated disc from reddish to ashy grey remarked by Harding, indicated a connection with our aurora borealis, in exhibitions of which similar rapid changes or alternations of colour are observed, and a very curious observation by Madler has been cited in the same direction On April 7, 1833, at 8 P.M., in a sky of extraordinary clearness and tranquillity, Venus, then in crescent phase, appeared to him accompanied by a beautiful radiating appearance, seven or eight straight rays, at times very bright and sharply defined at others fainter and more diffused, occupied the north west quadrant, and were gradually lost in the general ground of the sky The longest ray extended about 15 the shortest was about half that length, neither turning round the eye piece, nor viewing the planet in different parts of the field of the telescope, at all affected the phenomenon, which continued unchanged as long as Venus was observed that evening A figure of this appearance is annexed to Madler account of his observation

Zollner has expressed his conviction that under spectroscopic examination, the ash coloured secondary light of Venus will be found to present bright lines and it may be hoped that opportunities for such observation may occur during the present summer

By closely watching the form of the crescent towards the extremities further evidence of rotation in rather less time than is occupied by the earth in her diurnal revolution, may also be obtained But with this object, observations must be made at very short intervals In illustration of this may be quoted Madler's experiences on June 6 and 10 1836

	h m		
June 6,	10 41	Sid T	Both horns equally pointed, and the curvature quite elliptical
„	11 10	„	The same
„	11 6	„	The northern horn appears to be the more pointed
„	11 35	„	The northern horn certainly more pointed also at 11h 13
	11 56	„	Again uncertain
June 10,	11 14	„	Both horns alike
„	11 26	„	The northern is more pointed
„	11 58	„	Again doubtful

Madler referring to these and other observations of a similar character, in May and June 1836, expresses his opinion that they are quite irreconcileable with Bianchini's period of rotation, but may be compatible with the shorter one of Cassini and Schroter

THE MINOR PLANETS The following summary is founded upon elements of 153 members of this group which appear to be sufficiently well determined to afford reliable results. It exhibits the distribution of the perihelia, nodes, inclinations, and excentricities, and will be seen to offer several very decided characteristics

1 *Longitudes of the Perihelia*

	Number of Orbits		Number of Orbits
0 30	18	180 210	7
30 60	22	210 240	9
60 90	11	240 270	10
90 120	15	270 300	7
120 150	12	300 330	10
150 180	7	330 360	16

2 *Longitudes of the Ascending Nodes*

	Number of Orbits		Number of Orbits
0 30	15	180 210	19
30 60	13	210 240	8
60 90	17	240 270	5
90 120	6	270 300	7
120 150	13	300 330	15
150 180	16	330 360	16

3 *Inclinations to the Ecliptic*

0 5	52	20 25	6
5 10	58	25 30	2
10 15	6	30 35	1
15 20	5		

4 *Excentricities*

0 00 0 05	7	0 20 0 25	31
0 05 0 10	25	0 25 0 30	6
0 10 0 15	31	0 30 0 35	6
0 15 0 20	38	0 35 0 40	1

A FREE SPANISH UNIVERSITY

OUR readers will easily understand what sort of foster mother a Government like that of Spain would prove to education generally and to scientific education and inquiry in particular Any educational institution connected with such a state must necessarily be hampered and hindered in many ways, and the only means of obtaining perfect liberty in scientific education and instruction is to be certain and free of all State interference This has been so strongly felt in Spain by some of the foremost Spanish ... that they have formed an association to found an institution for free education A prospectus of the institution has been forwarded to us, and the difficulties which beset a liberal education in Spain may be learned from the fact that it is signed by ten ex-professors of the high standing, all of whom have been removed from their chairs by Government on account of their liberal opinions Among them are the names of Augusto G de Linares, ex-Professor of Natural History at the University of Santiago, and Laureano Calderon, ex-Professor of Organic Chemistry at the same University The object of the Association, is stated in the prospectus is to found in Madrid a free institution dedicated to the culture and propagation of science in its various branches specially by means of education A sort of joint stock company will be constituted by shares of 250 francs, payable in four instalments between July next and April 1877 A preliminary meeting was to be held on the ... to constitute the Society, and we earnestly hope that a successful start has been made The Association will be directed by a Council representing all parties interested The Institution itself will, of course, be perfectly free from all religious, philosophical, or political restriction, the only principles being the 'inviolability of science' and the perfect liberty of teaching There will be established according to the circumstances and means of the Society (1) studies for general, secondary, and professional education with the academic advantages accorded by the laws of the State, (2) superior scientific studies, (3) lectures and brief courses, both scientific and popular, (4) competitions, prizes, publication of books and reviews, &c The greatest precautions will be taken to obtain as professors men of undoubted probity and earnestness and of the highest competence

We need say nothing to our readers in recommendation of the above scheme All who sincerely desire the welfare of Spain and the spread of scientific knowledge must sympathise with its promoters who, we have every reason to believe, are men of the highest character and competency We hope that not a few of our readers will show their sympathy with the object of the Association by sending the moderate subscription which constitutes a shareholder to M. Laureano Figuerola, Calle de Alcala 72, Madrid.

question naturally arises, Why is it not more frequently employed for practical purposes?

Unquestionably the first experiments with electric light were not successful, but this is generally the case with new inventions. Unfortunately, however, a feeling seems to have arisen directly against the application of electricity for lighting purposes, or at any rate against the employment of the existing apparatus in the hope that more perfect may soon be invented.

The numerous cases in which powerful electric lights

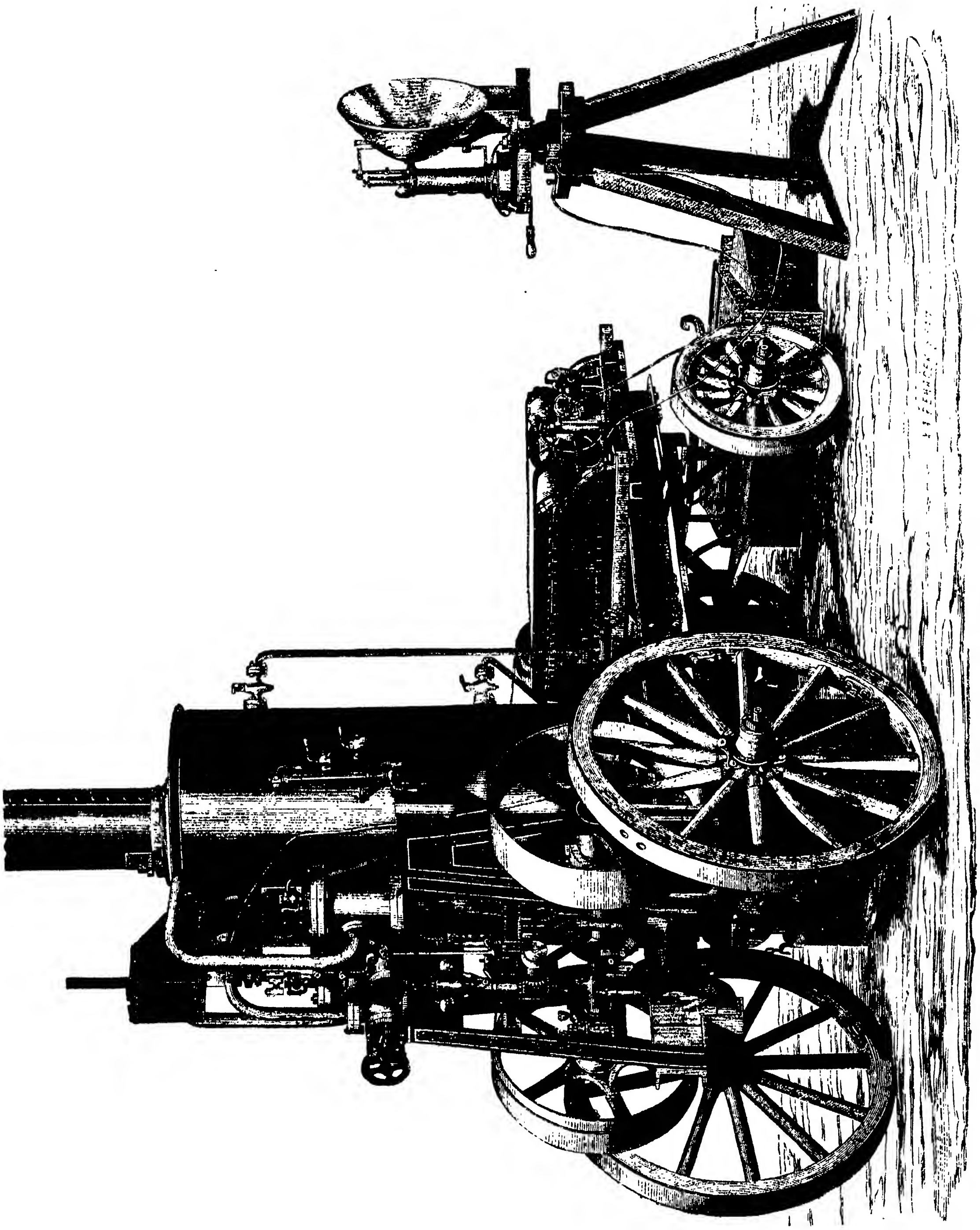


Fig. 1.—Dynamo-electric Light Apparatus with Portable Engine, Lamp, and Parabolic Reflector.

would be of service may be divided into two kinds: first those where a great number of lights are required at distant places, either simultaneously, or at intervals, and in varying numbers, such as lighting streets, extensive premises, &c. Second, those where only one or a few powerful lights are required, such as illuminating harbours and public places, as well as for lighthouses, signalling, and diving operations.

Great difficulty is experienced in properly adjusting the resistances and dividing the current, for the production of such a number of lights as is required in the cases of the first kind, and extensive experiments to overcome this difficulty have as yet been attended with only partial success

It is to those of the second kind that we purpose to draw attention Here the circumstances are quite altered, the cases of application are numerous, and the apparatus employed is perfect and proportionally cheap, and yet it is adopted not nearly so frequently as might be expected A constant light equal to that of from 9,000 to 10 000 stearine candles can easily be produced, with a motive force of from eight to nine horse power, and this at a cheaper rate than any other artificial light.

Such apparatus have lately been employed in various countries for various purposes, such as for engineering works, torpedo defences, signal lights, and in military field operations It is to be hoped that its adoption in this country will soon be more general

The following is a description of Messrs Siemens Electric Light Apparatus, one of many that have been adopted in various countries Comparative experiments have proved it to be the most powerful and at the same time the least expensive of all apparatus yet employed in the production of continuous electric light It is a complete apparatus by itself, in which the core of the armature is fixed and the wire helix alone caused to rotate By fixation of the armature core great inductive power is obtained, and consequently powerful currents

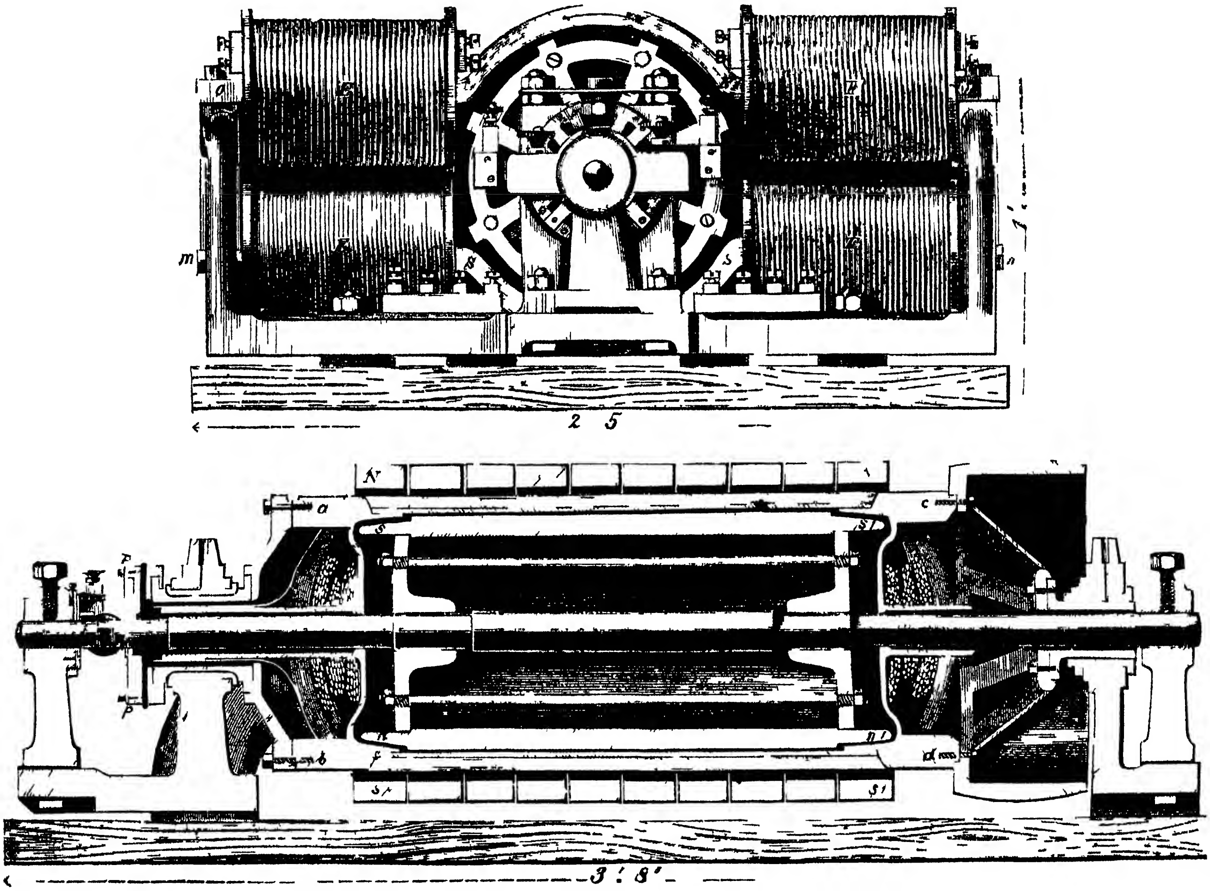


FIG 2 —End Elevation and Longitudinal Section of Dynamo electric Light Machine

With about 380 revolutions of the wire helix per minute, and nine to ten horse power, a light equal to 14,000 candles is obtained

The principle in this and all other magneto electric machines is, that when part of a closed electrical circuit is passed between the poles of a stationary magnet, a current is generated in the circuit the direction of which depends upon the position of the magnetic poles and direction of motion of the conductor.

In this machine (shown in Figs 1 and 2) the conductor, by the motion of which the electrical current is produced, is of insulated copper wire, coiled in several lengths, and with many convolutions on a cylinder of thin German silver, and in such a manner that each single convolution describes the longitudinal section of the cylinder. The whole surface of the metal cylinder is thus covered with wire, forming a second cylinder closed on all sides (*i*, *i*, *d*, Fig 2)

This hollow cylinder of wire incloses the stationary core of soft iron (*n s s n* Fig 2) which is fixed by means of an iron bar in the direction of its axis, prolonged at both ends through the bearings of the wire cylinder to standards Surrounding the wire cylinder for about two-thirds of its surface, are the curved iron bars (N N S S′ Fig 2), separated from the stationary iron core by space only sufficient to permit the free rotation of the wire cylinders The curved bars are themselves prolongations of the cores of the electro magnets (I F F I) and the sides of the two horse shoe magnets (N *o*—S, *m* and N *o*—S, *m*) are connected by the iron of the two standards (*i m* and *o m*)

As the coils of the electro-magnets form a circuit with

the wires of the revolving cylinder, the revolution of the latter causes a powerful current to pass into the electro-magnetic coils, this again inducing a still more powerful current in the wires of the cylindrical armature. The iron core of the cylindrical armature being very close to the poles of the electro-magnets, becomes itself an intensely powerful transverse magnet of opposite polarity to the electro-magnet. The cylinder of wire thus revolves in a very intense magnetic field.

These electrical currents are collected on two metal rollers or brushes, so that at two points diametrically opposite the single sectors pass under the rollers or brushes with elastic pressure giving up to them their electrical charge.

A slight increase of speed in the rotation of the wire cylinder is followed by a considerable increase of current, but as the current increases, so does the resistance to rotation; and this very rapidly. In addition to this heat is developed to such an extent, that care must be taken not to exceed a certain limit, otherwise, the insulation of the coils would be destroyed. Were it not for this drawback almost any amount of current might be produced with suitable driving power.

As the external resistance affects the strength of the current the speed must be varied accordingly, being greater as the external resistance is greater and *vice versa*. With an electric lamp in a circuit of small resistance, if the machine is intended to work continuously, the revolutions of the wire cylinder per minute should not exceed 370 to 380. The temperature of the machine will then be at a maximum in about three hours; and during work will remain constant. At this speed the driving power is about eight indicated horse-power. While the intensity of the light, unaided by reflector or lens, has been shown by various photometers to be equal to 14,000 normal English candles. A more intense electric light cannot be obtained as any increase in the current splits up even the best carbon.

The conducting wires from the machine to the lamp should be of copper, offering very little resistance and at the same time possessing a high electrical conductivity. If the lengths of the two wires do not together exceed fifty-five yards, then a wire of 0·157 inches diameter, and of high conductivity will suffice. For longer distances it is advisable to use a strand of larger diameter.

Increased speed will of course compensate for decrease of current due to a too great external resistance, but this can be done only at the expense of increased motive power.

The lamp used with the machine is regulated without clockwork, as the employment of the latter has not only been a source of numerous failures and difficulties, but is liable to disarrangement upon the least rough usage. The lamp of itself regulates the carbon points, keeping them at a uniform distance, and thus a perfectly steady light is produced.

For concentration either a parabolic reflector or a Fresnel dioptric lens may be used.

For transportation the Dynamo-electric Light Apparatus is mounted on a waggon, with steam-engine, the whole weighing 4,960lbs. The combination has proved very serviceable on account of its lightness and compactness.

THE ETHNOLOGY OF THE PAPUANS OF MACLAY COAST, NEW GUINEA[1]

WITH regard to the villages and dwellings. So thickly is the coast of Astrolabe Gulf covered with vegetation that no houses are visible to anyone on shipboard, the only signs of habitation being perhaps columns of smoke. If, however, more careful observation be made with a telescope, separate groups of cocoa nut palms will be noticed

[1] Continued from p. 109.

If a landing be effected near one such group, a *pirogue*, or canoe, will probably be seen drawn up on the shore, or else concealed in the jungle, and a path will be found leading through the wood to an open clearing, where stand huts overshadowed by bananas and cocoa-nut palms. Viewed from the side, one such hut seems almost wholly to consist of roof; as the side walls rise scarcely half a yard above the ground. A semi-circular eave-like projection frequently stands out over the doorway. Close in the neighbourhood of nearly every hut there stands upon four legs the *barla*, a kind of table or bench, which serves as the eating and resting-place of the men. Upon this, when the meal is ready, the host and his guests are seated, so that they can take their meal without fear of molestation from pigs or dogs. When the dishes are cleared away the Papuan takes his *siesta* upon the *barla*, which now serves as a kind of divan. The women on no account use the *barla*, but take their meals upon the ground. A village consists of several groups of huts (each group having a particular name) which stand around an open clearing, and communicate through narrow paths. The houses do not stand upon piles,[1] and are for the most part small and dark, though well and strongly built; the roofs in particular, which do not have a flatly-inclined surface, but bulge outside in order that the rain may be the easier carried off. The walls are made either of bamboo or of the stalks of sago-palm leaves. The door is raised generally about half a yard above the ground, to prevent the ingress of dogs and pigs.

There can generally be distinguished three kinds of hut—those of single people, those of families, and the [illegible], which is usually only used by men, being intended for the youths of the village, and any chance guest. Here will be remarked the [illegible],[2] a kind of gong, which plays so important a part in the life of the Papuans. It resembles a thick split beam resting upon two trestles, and on the middle of the outer side may be seen a smooth, much-worn patch, the place where it is hit with a very thick stick, by which is produced a dull but loud tone, which has been heard on the coast at as great a distance as five or six miles. All important events, *e.g.* the presence of an enemy, a death, or a feast, are by this instrument heralded to the neighbouring villages, the quality of the news being signified by the varying loudness of the tones produced, and the length of the pauses between each."

It is a most extraordinary fact that all the people of the coast here have no means at all of making fire; wherefore they are obliged always and everywhere to carry a live coal with them, be it either to kindle a fire in a plantation, or, when on a long tour in the mountains, to relight their cigars, which, being wrapped in green leaves, are always going out. On their sea voyages they have generally a live coal at the bottom of the boat, in a broken pot partly filled with earth. Those who remain behind in the villages never forget to look after the fire, and even in the night a small fire is kindled under the sleeping places, which partly makes up for scanty clothing. The warmth penetrates, together with smoke, through the interstices of the bamboo bedstead,[3] so that one-half of the sleeper's body is warmed, in fact roasted, while the other half is frozen. They are often obliged to get up in the night to see after the fire. The mountain people are not obliged thus to tend, like the priestesses of Vesta, an eternal flame, but understand how to kindle fire anew, and by the following method. A piece of very dry wood, which they term *Hol*, is split with a stone axe in such a manner that each half is not quite separated from the other. Into the fissure a strong cord, a split liana,

[1] The houses of all Malays, whether on the coast or in the mountains, always are built upon piles sometimes nine or ten feet long.—J. C. G.
[2] A similar instrument is figured in Schweinfurth's "Heart of Africa," as in use by the Niam-Niam tribe.—J. C. G.
[3] This is probably the equivalent of the *bali bali* of the Malays, a frame of split bamboo, raised slightly from the ground.—J. C. G.

in fact, is introduced, and, after that the piece of wood has been firmly pressed against the ground by the foot or knee, is put into a continually increasing frictional movement until some dry cocoa nut bark fibre, previously placed beneath, takes fire. This is a very tedious proceeding, as it lasts well nigh half an hour. The aborigines of the coast have repeatedly told Maclay that they are frequently obliged to go to other villages to procure fire when by chance the fires in all the huts of a village have gone out.

The Papuans pass most of their time outside their huts, these latter serving principally as shelter during the night, or in bad weather. To the tie-beam of the hut a cord is fastened, from which hangs a *mimu*, i.e. a stick with several hooks. In front of the stick a portion of the covering of the base of the leaf of the sago palm is so arranged that the cord passes through the middle of the same. To the hooks are hung various articles of food wrapped up in leaves. This arrangement serves to keep off the mice, which would otherwise make away with everything eatable in the night. Beyond a pair of spears, a few arrows, and other implements of the chase, there is nothing in the way of furniture in the hut of the Papuan. It would be difficult, in fact, to find a human habitation more meanly furnished. It is the custom to preserve [illegible] the lower jaw, of every animal which has been eaten at feasts. These [illegible] are hung around the walls of the large common hut—*[illegible]*.

The plantations, or gardens, of the Papuans are seldom [illegible] the huts, but for the sake of [illegible] are hidden [illegible]. A clearing is made by cutting down the [illegible] and after it has been dried in the sun, it is [illegible]. The place thus prepared is then surrounded by a kind of hedge consisting of two rows of a kind of [illegible] (*[illegible]*), which soon takes root, the opposite stems being fastened together with lianas, and the [illegible] space between the rows filled with rough hewn logs. In less than a month's time a new plantation is put in full order and planted with bananas, sugar cane, and the Colocasia and Dioscorea. The tools which are used for this purpose are very simple, being the *[illegible]*, a strong stick about two yards in length, and sharpened at one end—the implement of the men; and the *[illegible]*, which is used by the women, a kind of small spade. The Papuans have throughout the year a rotation of fruits and vegetables. Every day the women go forth to fetch from the plantations what is necessary for the same evening and the following morning. The coast people have the most property in cultivated land, while the islanders are chiefly employed in the manufacture of pots, dishes, and canoes.

Among the Papuans of Maclay Coast there exists neither trade nor a regular system of barter. If for instance, the coast people visit their neighbours or the people of the hills, or the islanders, they bring with them as a present all the superfluous articles which they possess, and on their departure receive as presents productions of the village which they have visited. Maclay has never seen one single present given or demanded in return for an equivalent gift.

Not many villages are in possession of *pirogues* (canoes), because most of those on the coast are situated in the neighbourhood of a surf so strong as to make landing impossible. The canoes are hewn out of a single tree-trunk, and have an outrigger (Aussengestell), and are manned by two rowers. The inhabitants, however, of Bili Bili and of the "Archipelago of Contentment," build larger canoes, provided with two masts, "taking" one fore, the other aft. In these canoes the aborigines can sail with the most unfavourable winds. The large sail consists of a pandanus[1] mat, and split bamboo and lianas serve as sheets and shrouds. The anchor is a piece of a tree trunk, of which four or five branches encircling it, after being cut short and sharpened to a point, serve as the "flukes," and is weighted by means of a number of stones attached to the shank by a sort of basket-work. Neither the coast people nor the inhabitants of the hills undertake voyages of any considerable extent.

With a few words on the daily life of the Papuans this article must be brought to a close. The Papuan of Maclay Coast marries early, and leads, morally speaking, a most model life, extra connubial alliances being seldom, or never, formed. The marriage settlements are very simple, the bridegroom making, on agreement with the bride's family, a few presents, such as dishes and dyed cloths. A few days after, a pig or a dog is slain, the marriage feast is celebrated, and the young man takes his bride off to his hut. There is a much simpler procedure, the event being marked by no feast, when a man divorces his wife because she is unable to work, perhaps on account of lameness, for he simply sends her off and takes another. In other respects the men treat their wives well, for it is very seldom that a wife is beaten. The women however, do all the hard work and carry heavy burdens, so that the freshness and healthiness of youth soon passes away. The children are very cheerful, and seldom scream. They are more petted by the father than by the mother, and Maclay has actually seen, what is very uncommon among savages, toys, in the shape of model canoes and a kind of top. They, however, in childhood learn all the pursuits of manhood, and early accompany their father into the plantations or on his fishing excursion. It is a comical, though not uncommon sight to see a boy of four years old gravely tend the [illegible], fetch wood, clean the dishes, help his father to peel fruit, and then, on the entrance of his mother, run to her and begin to take the breast. The women suckle for far too long a time, which, more than even overwork, is the cause of their having such small families. The day of the Papuan begins with the early dawn, and he loves the crow of the cock which heralds the approach of day. Even if he has nothing particular to do, off he goes to the shore, while it is yet dusk, enveloped in his *[illegible]*, and with chattering teeth awaits the sunrise. When his wife is already off to the plantation, he lingers over his breakfast, and then either chews betel or smokes a green cigar. About ten o'clock the men depart to their various occupations, and if a visit be paid to a village at noon, not a human being will be seen, but a dog or a pig or two will come out and inspect the intruder, and then disappear again. About four or five in the afternoon the men return, dripping from their daily bath. In spite of numerous skin diseases the Papuans can scarcely be termed dirty, for they daily, often several times a day, take a bath and rub their skin with sand or grass. Later on in the evening come their wives, sweating and staggering under their heavy burdens. Supper is then made ready. Into the *[illegible]* are emptied the most incongruous food stuffs, reminding us almost of the "ingredients" of the witches' caldron in "Macbeth," *e.g.* beetles, snails, crabs, caterpillars, and small lizards! On these colocasia or dioscorea are put and over all water, a third part being sea water, is poured, and the pot, covered with green leaves, is then set on the fire to boil. When all is ready, the master of the house distributes the portions, the worst morsels to his wife and children, reserving the best for himself and his guests. In order to obtain a *soupçon* of some flavour, the brine is drunk in which the food was cooked. After a cigar or a quantum of betel, the men retire to rest, previously taking care to light a fire under their bedsteads. So passes away the day of the Papuan, varied only by an occasional excursion, or a feast, or a preparation for war.

JOHN C. GALTON

[1] *Pandanus* is the generic term for the family of Screw palms.—J. C. G.

NOTES

THE first of the series of the free science lectures in connection with the Loan Collection of Scientific Instruments was given on Saturday evening at eight o'clock. The notice issued was but short, yet the room was not only as full as it could be, but the crowd was such that if space for 1,000 had been provided, all the places would have been occupied. The lecturer, as we announced, was Prof. Roscoe, and his subject was "Dalton's Instruments, and what he did with them." The following gentlemen have already volunteered to give their valuable assistance for future lectures, which will take place on Monday, Tuesday, and Saturday evenings at 8 o'clock:—Prof. F. A. Abel, F.R.S., President of the Chemical Society, Capt. Abney, R.E., F.R.S., Prof. Roscoe, F.R.S., Dr. Warren De la Rue, F.R.S., Prof. G. Carey Foster, F.R.S., President of the Physical Society, Dr. J. H. Gladstone, F.R.S., Prof. Guthrie, F.R.S., Mr. J. Baillie Hamilton, Mr. Norman Lockyer, F.R.S., Rev. R. Main, M.A., F.R.S., the Right Hon. Lord Rayleigh, F.R.S., Dr. W. J. Russell, F.R.S., Mr. W. Spottiswoode, M.A., F.R.S., Dr. W. H. Stone, Rev. S. J. Perry, F.R.S., the Right Hon. Lyon Playfair, M.P., F.R.S., the Right Hon. the Earl of Rosse, F.R.S., Mr. C. V. Walker, F.R.S., Mr. W. C. Roberts, F.R.S., Mr. W. H. Preece. The next lecture will be given on Saturday evening by Prof. Guthrie, On Cold; on Monday the Rev. S. J. Perry will lecture On the Transit of Venus Instruments. It is proposed to give the following demonstrations on Saturday, Monday, and Tuesday next:—11 A.M., Marine Engines in Motion; 11.30, Fog Horns, Electric Light, Spectrum of Electric Light; 12.45 P.M., Time Gun; 1.30, Radiometers; 2 to 5, Pictet's Ice-making Machine; 2.30, Orreries; 3, Sir J. Whitworth's Millionth Measuring Machine and True Planes (Monday only); 3.30, Electric Light, Musical Instruments (Monday only), Ancient Musical Instruments (Tuesday only); 4.30, the *Times* Type-Composing Machine; 7.30, Telegraphic Apparatus (Monday and Tuesday only); 8, Sir J. Whitworth's Machines (Monday only); 8 to 9, Little Basses' Lighthouse; 8, Lecture in Conference Room (Saturday and Monday). In the list of papers read on Tuesday week we omitted to mention those of Dr. C. B. Fox, "On the Employment of Aspirators in Atmospheric Ozonometry," and Mr. J. Allan Broun "On Barometric Variations and their Causes." On Thursday, besides the papers already mentioned, Dr. Rae made a communication on Arctic Maps. On Friday Mr. W. S. Mitchell read a paper on the MS. tables and maps of William Smith. On Whit Monday 11,964 people visited the Collection; on Tuesday the number was 5,656.

AT the meeting of the American Academy of Science, on March 8, the president, Hon. Charles Francis Adams, presented the Rumford medals (in gold and silver) to Dr. John W. Draper, for his researches in radiant energy. In presenting the medals, the president alluded, among other matters, to Dr. Draper's discovery, in 1840, of the peculiar phenomena commonly known as Moser's images, to his method of measuring the intensity of the chemical action of light, afterwards perfected and employed by Bunsen and Roscoe in their investigations, and especially to his elaborate investigation, published in 1847, in which Dr. Draper established experimentally several important facts in spectrum analysis.

ON Thursday, June 1, M. Dumas, the eminent chemist, delivered his inaugural address, as the new member of the Académie Française. M. Dumas read in a clear and impressive tone. His task was to deliver an *éloge* on M. Guizot, whose career touched science at very few points. M. Dumas accomplished his duty with perfect tact, and used language which his hero would have wholly approved.

AT a meeting recently held in Sydney it was resolved to obtain subscriptions to enable Signor D'Albertis to carry out a scheme for the exploration of New Guinea. This well-known naturalist and explorer proposes to ascend the Fly river to the centre of the island, where very probably the river has its sources, and to find his way back by land to Yule Island or Port Moresby. The journey altogether will probably last from eight to twelve months, and he would require a steam-launch, 35 or 40 feet long, with furnaces for burning wood, besides a small contingent of men. He will obtain all possible information as to the geography, fauna, flora, and mineralogy of the district traversed. Signor D'Albertis offers himself to subscribe at least 200*l*. to the expedition. The New South Wales Government, we are glad to see, has put the steam-launch *Neva* at Signor D'Albertis' disposal, and we have no doubt that by this time the very moderate sum required has been subscribed.

SIR JOSEPH WHITWORTH was on Thursday last presented with the freedom of the Turners' Company.

AT the last meeting of the Lisbon Commercial Association it was proposed to ask the Government to send an expedition to carry out Lieut. Cameron's projects, starting from Angola. The suggestion was made that scientific men should accompany the expedition.

THE President and Council of the Geological Society hold a reception on Saturday evening at the Society's rooms, Burlington House.

AMONG the passengers in the mail steamer *Artuasus*, which sailed from Leith on the 2nd inst. for Iceland, are Prof. Jonstrup, M. Fieldberg, surveyor, and M. Gronlund, botanist. On arriving at Iceland these gentlemen are to be joined by Lieut. Njdal, of the Danish gunboat on the station, and an expedition is to be formed to proceed to the scene of the recent volcanic eruption.

ON Saturday afternoon the annual meeting of the Board of Visitors of the Royal Observatory, Greenwich, was held, at which the report of the Astronomer Royal, Sir G. B. Airy, was read.

REGULAR courses of lectures have been established at the Naval Observatory, Montsouris, for the officers of the French national navy attached to the establishment. The general principles of Astronomical Observations are lectured upon by M. Loewy; Special Naval Methods, by Capt. Turquet, the Director of the establishment; Terrestrial Magnetism, by M. Marié Davy, Director of the Montsouris Observatory; Spectroscopy, by M. Cornu; Photography in its Application to Astronomy, by M. Angot, of the National Observatory of Paris. All the observations made by the pupils are submitted to correction, and will be utilised as far as possible for the improvement of *Connaissance des Temps*.

THE Municipal Council of Paris voted some time since money for organising a number of meteorological observatories, to be modelled after the Montsouris pattern, and to be located in the several districts of Paris. The Prefect of the Seine has appointed a Commission, to organise these observatories on the top of several public buildings, divided as far as possible from among the several districts.

A TESTIMONIAL was recently presented at Wisbech to Mr. S. H. Miller, F.R.A.S., F.M.S. The testimonial, subscribed for by a large number of gentlemen in the district, is of the value of about 100*l*., and the inscription on the plate states that it is "presented as some acknowledgment of the value of the services he has rendered to the interests of education, science, and agriculture."

The French Senate and the French Chamber of Deputies, are both of them busy with educational matters. The Government has proposed to the Senate to restore the National Institute of Agriculture, which had been established at Versailles by the second Republic but was abolished by the Empire. The Chamber of Deputies has voted, after a very interesting address delivered by M. Waddington, the Minister for Public Instruction, the first reading of a Bill restoring to the Government the right of appointing examiners for granting honours to the pupils of the so-called Free Universities.

The volume of the *Zoological Record* for 1874 has just reached us. Under the editorship of Mr. E. C. Rye, Librarian to the Royal Geographical Society, Mr. E. R. Alston has undertaken the Mammals, Mr. R. B. Sharpe and Dr. Murie the Birds, Mr. O'Shaughnessy the Reptiles and Fish, Prof. E. von Martens the Molluscs and Crustacea, Rev. O. P. Cambridge the Arachnida, Mr. Rye the Myriapoda and Insects, whilst Dr. C. F. Lütken has taken the lower Invertebrata. Mr. Rye acknowledges a grant of 100*l*. from the British Association and 50*l*. from the Zoological Society towards the expenses of the *Record*.

The Watford Natural History Society now numbers 170 members of all classes.

The conductors of the Botanical Locality Record Club have shown themselves amenable to criticism, and have rendered their proceedings much less obnoxious to the objection at one time raised against them, that they were doing their best to promote the extirpation of rare plants. Their Annual Report for 1875, just issued, is a valuable publication. It is divided into five parts. In the first division they give new "County Records" of various species and sub-species, very few special localities being given; in the second, a "General Locality List," including all observations of interest made during the year; in the third, a list of "Extinctions, Reappearances, and Confirmatory Records;" in the fourth, a list of "Aliens, Casuals, and Escapes;" in the fifth, "County Catalogues of Plants;" those in the present month being Merioneth and Montgomery and Stirling. In the case of three counties, North Lincoln, Stirling, and Roxburgh, there is in the present Report an addition of upwards of fifty species of flowering plants and Vascular Cryptogams to those previously recorded. The divisions of counties are those adopted by Mr. H. C. Watson. There ought soon to be but little addition possible to our knowledge of the distribution of British plants.

During the coming summer (July and August) opportunity will be given at Cincinnatti Observatory, University of Cincinnati, for the study of Higher Analysis, Spherical and Practical Astronomy, and Celestial Mechanics. These advantages are intended, primarily, for teachers who may desire to spend their vacation in the pursuit of studies connected with their own work. Special attention will be paid to the art of computing, in order to give an insight into the practical application of mathematics to astronomy. Opportunity will also be afforded to learn the use of instruments. The Americans certainly seem to be ahead of us in the opportunities they devise for varied practical scientific work.

Messrs. Jarrold and Sons will shortly publish "Rambles of a Naturalist in Egypt and other Countries," by Mr. J. H. Gurney, jun.

On the 29th and 30th inst. an interesting trial of the sagacity, activity, and docility of Collie dogs will take place at the Alexandra Palace. The dogs will be tried successively in the management of one hundred Welsh wethers.

To those of our readers who are fond of either the rod or the gun, and who intend to spend their holidays in Scotland, we strongly recommend Mr. Watson Lyall's "Sportsman's and Tourist's and General Guide to the Rivers, Lochs, Moors, and Deer Forests of Scotland." It contains a vast amount of information, including frequent details as to the natural features and objects of antiquarian interest in the various districts. Those who cannot take a holiday will be quite refreshed by an occasional dip into it at the season when "everybody" is supposed to be out of town. A special large-scale extremely well-constructed map of Scotland accompanies the "Guide," as also a map of England.

Bentley and Trimen's "Medicinal Plants" has now advanced as far as the seventh part. Each part contains seven or eight coloured plates, with full descriptions of plants which are officinal in the pharmacopœias of England and the United States. The quality of both letter-press and figures is well maintained; and when complete the work will be an absolutely indispensable one to the pharmacologist.

"The Work and Problems of the Victoria Cave Exploration" is the title of an interesting paper read recently by Mr. R. H. Tiddeman before the Geological and Polytechnic Society of the West Riding of Yorkshire. It is printed by McCorquodale and Co., Leeds.

A work entitled the "Anatomia dell' Ape," by Clerici, has been recently published at Milan under the auspices and special supervision of the Central Italian Bee-keepers' Association. This highly interesting publication consists of a series of thirty beautiful chromo-lithographic plates, 8 inches wide by 12 inches high, artistically produced, with admirable frontispiece for binding. We understand that the execution of this anatomical work his occupied considerable time, and that prizes have been awarded to it at the Vienna Exhibition and elsewhere. In connection with this we may note the receipt of a useful little "Manual of the Apiary," by Mr. A. J. Cook, of the Michigan State Agricultural College.

We are glad to see from the 62nd Annual Report of the Royal Geological Society of Cornwall that that Society continues to be prosperous and useful.

The Twenty-Second Annual Report of the Brighton and Sussex Natural History Society, which is in a prosperous condition, contains the following among other papers:—"On Recent Excavations at Cissbury," by Mr. Ernest Willett; "On Wingless Birds," by Mr. T. W. Wonfor; "What is a Brachiopod?" by Mr. T. Davidson, F.R.S.; and on "The Birds and Mammals of Sussex," by Mr. F. E. Sawyer.

An English translation has been published of Lieut. Weyprecht's admirable address given at Graz last September, on the "Fundamental Principles of Arctic Exploration," of which we gave an abstract at the time. We believe it may be obtained in London from Trübner and Co.

The additions to the Zoological Society's Gardens during the past week include an Ocelot (*Felis pardalis*) from Para, presented by Mr. W. A. Sumner; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. C. H. A. Forbes; four Fawn-coloured Field Mice (*Mus cervicolor*) from India, presented by Col. C. F. Sturt; a Blue Jay (*Cyanocitta cristata*) from North America, a Chinese Jay Thrush (*Garrulax chinensis*) from China, presented by Mr. E. Hawkins; two Barnard's Parrakeets (*Platycercus barnardi*) from Australia, deposited; a White-throated Capuchin (*Cebus hypoleucus*) from South America, a White-bellied Sea Eagle (*Haliaetus leucogaster*) from Australia, a Derbian Screamer (*Chauna derbiana*), two Green-billed Curassows (*Crax viridirostris*), a Red-billed Tree Duck (*Dendrocygna autumnalis*) from Cartagena, purchased; a Bonnet Monkey (*Macacus radiatus*), born in the Gardens.

LOAN COLLECTION OF SCIENTIFIC APPARATUS

SECTION—MECHANICS

PRIME MOVERS

THE subject on which I have now the honour to address you, the subject which is to occupy our attention to-day, is that of prime movers, that is to say, we are about to consider that class of machines which, to use the words of Tredgold, "enable the engineer to direct the great sources of power in nature for the use and convenience of man."

Although machines of this kind are, in truth, mere converters or adapters of extraneous forces into useful and manageable forms, and have not any source of life, power, or motion, in themselves, nevertheless they impress us with the notion of vitality; and it is difficult to regard the revolving shaft of a water-wheel or turbine, set in motion by some hidden stream, or to gaze upon the steam-engine actuated by an unseen vapour, without, as I have said, the idea being raised in our minds that the machines on which we are looking are really endowed with some kind of life.

The invention of such machines marks a very great step in the progress of mechanical science in the world, as it commences an era distinct from that in which mere machines to be acted on by human or animal muscular force were alone in existence. Machines such as these, highly useful as they may be, are, after all, only tools or implements more or less ingenious and more or less complex.

Mankind could not have been very long upon the earth before they must have found the need and must have discovered the utility of some kind of tool or implement; they must soon have found that the direct action of the power of the arm, which was not enough by itself to break up some obstacle, became sufficient if that action were applied by the wielding of a heavy club, or through the putting into motion of a large stone, and thus the hammer or its equivalent must have been among the earliest of inventions. Such an implement must soon have taught its users that muscular force could be exercised through a considerable space, could be stored up, and could be delivered in a concentrated form by a blow.

Similarly it could not have been long before it must have been found that to raise water in the hollow of the hand by repeated efforts was not so convenient a mode as to raise it in a bent leaf or in a shell, and in this way another implement would speedily be invented. We might pursue this line of speculation, and doing so we should readily arrive at the conclusion that (without attributing to the early inhabitants of the earth any profound acquaintance with mechanics) the hammer, the lever, the wedge, and other simple tools and utensils, must soon have come into existence; and we should also be led to believe that when, even with the aid of tools such as these, a man singly could not accomplish any desired object, the expedient of combining the power of more than one man to attain an end would soon be thought of, and that the requisite appliances, such as large beams used as levers, numerous ropes (which must very early in the history of the world have been twisted from filaments) and matters of that kind, would come into use. For a corroboration of this view, if one were wanted, the fact may be cited that on the discovery of any isolated savage community it always is found to have advanced thus far in mechanical art.

But passing from such machines as these, which are rather of the character of tools and implements, than machines, as we now popularly use the word, one knows that even complicated mechanism for the purpose of enabling muscular force to be more readily applied, is of very ancient date. On this point I will quote from only one book, that is the Bible, where, at the 10th and 11th verses of the 11th chapter of Deuteronomy, a statement is made clearly indicating that in Egypt irrigation was carried on by some kind of machine worked by the foot; whether the treadwheel with water-buckets round about it mentioned by Vitruvius, or whether the plank-lever with a bucket suspended at one end and worked by the labourer running along the top of the lever to the other end (an apparatus even now used in India), we do not know; but that it was some machine worked by the foot is clear, the statement being that when the Israelites had reached the Promised Land they would find it was one abounding in streams, so as to be naturally watered, and that it would not require to be watered by the foot as in Egypt. Again, in Chronicles it is related that King Uzziah loved husbandry, and that he made many engines, unhappily not in connection with agriculture, but for warlike purposes, "to shoot arrows and great stones withal." Further, in the 7th chapter of the Book of Job, we have the comparison of the life of man passing away swifter than a weaver's shuttle; this points unmistakeably to the fact that there must in those days have been in existence a loom capable of weaving fabrics of such widths that the shuttle required to be impelled with a speed equal to a flight from one side of the fabric to the other, and no doubt such a fabric must have been made in a machine competent at last to raise and depress alternately the halves of the warp threads. The potter's wheel also is frequently mentioned in the Bible.

Such instances as these are sufficient to show that considerable progress must have been made in the very earliest days of history in the construction of machines whereby muscular force was conveniently applied to an end; but if we leave out of account, as we fairly may, the action of the wind in propelling a boat by sails, and the action of the wind in winnowing grain, I think we shall be right in considering that in the times of which I have been speaking there did not exist any machine in the nature of a power-giver or prime mover.

Doubtless the want of a greater force than could be obtained from the muscles of one human being must have soon made itself felt; and intelligent men, conscious of their own ability and of their mental power of directing a large amount of work, must have been grieved at finding the use of that power circumscribed by the limited force of their own bodies, and therefore early in the world's history there must have been the attempt, by the offer of some consideration or reward, to induce other men (men gifted with equal or stronger muscles, but probably not with equal minds) to work under the directions of these men of superior intelligence. But when such aid as this became insufficient, the way in which, in all probability, the people of those days endeavoured to satisfy the further demand would be to make captives of their enemies and to reduce them into a state of bondage, to grind at the mill, to raise water, or, yoked by innumerable cords and beams to some heavy chariot or sledge, to draw along the huge blocks required in the foundations of a temple, or for the building of a pyramid, or to act in concert on the many oars of a galley, although by what means this last-named operation was performed is not very clear. Doubtless under this condition of things there must have been an amount of human suffering which is too frightful to be contemplated.

Such machines as those to which I have called attention could not have been invented and brought into use without the exercise of much mechanical skill; but considerable as this skill must have been it had never originated a prime mover; it had given no source of power to the world, but had left it dependent on the muscular exertions of human beings and of animals.

Great, then, was the step, and a most distinct era was it in mechanical science, when for the first time a prime mover was invented and a machine was brought into existence which, utilising some hitherto disregarded natural force, converted it into a convenient form of power, by which as great results could be obtained as were obtainable by the aggregation of a large number of human beings, and could be obtained without bondage and without affliction.

There are probably few sights more pleasing to one who has been brought up in factories than to watch a skilful workman engaged in executing a piece of work which requires absolute mastery over the tools that he uses, and demands that they should have the constant guiding of his intelligent mind. Handicraft work of such a kind borders upon the occupation of the artist, and to see such work in the course of execution is, as I have said, a source of pleasure. But when descending from this the work becomes more and more of the character of mere repetition, and when it is accomplished by the aid of implements which, from their very perfection require but little mind to direct them, and demand only the use of muscle, then, although the labour, when honestly pursued, is still honourable, and therefore to be admired, there comes over one a feeling of fear and of regret that the man is verging towards a mere implement. But when one sees, as I have seen in my time, in England, and as I have seen very recently on the Continent, men earning their living by treading within a cage to cause it to revolve and thereby to raise weights, an occupation demanding no greater exercise of intelligence than that which is sufficient to start, to stop, and to reverse the wheel at the word of command, one does indeed regret to find human beings employed in so low an

[1] Address delivered by F. J. Bramwell, C.E., F.R.S., one of the vice-presidents of the Section, May 25.

occupation, an occupation that places them on a level with the turnspit. It is one which is most properly meted out in our prisons as a punishment for crime, accompanied, however, with the degradation that the force exerted shall be entirely wasted in idly turning a fan in the free air, and thus the prisoner, in addition to the fatigue of his body, undergoes the humiliation of, as he expresses it, "grinding the wind."

If they played no other part than that of relieving humanity from such tasks as these, prime movers would be machines to be hailed.

True it is that the labourers who were thus relieved would not thank their benefactors, and indeed so far as the individuals subjected to the change were concerned they would have cause not to thank them, because they having been taught no other mode of earning a livelihood, and finding the mode they knew set on one side by the employment of a prime mover, would be at their wit's end for a means of subsistence, and would be experiencing those miseries which are caused by a state of transition. But in some way the men of the transition state must be relieved, and in the next generation, it no longer being possible to subsist by such wholly unintelligent labour, the energies of their descendants would be devoted to gaining a livelihood by some occupation more worthy of the mind of man.

Early prime movers, from their comparatively small size, probably did little more than thus relieve humanity; but when we come to consider the prime movers of the present day, by which we are enabled to contain within a single vessel and to apply to its propulsion 8,000 indicated horse-power, or an equivalent of the labour of nearly 50,000 men working at one time, we find that the prime mover has another and most important claim upon our interest: it enables us to attain results that it would be absolutely impossible to attain by any aggregation of human or other muscular effort, however brutally indifferent we might be to the misery of those who were engaged in that effort.

Excluding from our consideration light and even electricity, as not being, up to the present time, sources of power on which we rely in practice, there remain three principal groups into which our prime movers may be arranged, viz., those which work by the agency of wind, those which work by the agency of water, and those which work by the agency of heat. But some of these great groups are capable of division, and indeed demand division into various branches.

Water power may be due to the impact of water, as in some kinds of water-wheels, turbines, and hydraulic rams, or to water acting as a weight or pressure, as in other kinds of water-wheels, and in water-pressure engines; or to streams of water inducing currents, as in the case of the jet-pump, and of the "Trombe d'eau," or to its undulating movements, as in ocean waves. The ability of water to give out motive force may arise from falls, from the currents of rivers, from the tides, or, as has been said, from the oscillation of the waves.

Prime movers which utilise the force of the wind are few in number and in all cases act by impact.

As regards those prime movers which work by the aid of heat, we may have that heat developed by the combustion of fuel, and being so developed applied to heating water, raising steam, and working some of the numerous forms of steam-engines; or, as in the case of the Giffard injector, performing work by induced currents, by the flow of steam; or we may have the heat of fuel applied to vary the density of the air, and thus to obtain motion as by the smoke-jack; or the fuel may be employed to augment the bulk and the pressure of gases, as in the numerous caloric engines; or we may have heat and power developed in the combustion of gases, as in the forms of gas-engines; or in the combustion of explosives, as in gunpowder, dynamite, and other like materials, used not only for the purposes of artillery and of blasting, but for actuating prime movers in the ordinary sense of the word.

Again, we may have the heat of the sun applied through the agency of the expansion of gases or surfaces to the production of power, as in the sun-pumps of Solomon de Caus and of Belidor, and as in the sun-engine of Erricsson. Finally, we may have the sun's rays applied direct, as in the radiometer of Mr. Crookes.

A consideration of the foregoing heads, under which prime movers range themselves, will speedily bring us to the conclusion that the main centre of all mechanical force on this earth is the sun. If the prime movers be urged by water, that water has attained the elevation from which it falls, and thus gives out power by reason of its having been evaporated and raised by the heat of the sun. If the power of the water be derived from the tidal influence, that influence is due to the joint action of the sun and the moon.

If the prime mover depend upon the wind for its force either directly, as in windmills, or indirectly, as in machines worked by the waves, then that wind is caused to blow by variations of temperature due to the action of the sun. If the prime mover depend upon light or upon solar heat, as in the case of the radiometer and of the sun engine, then the connection is obvious; but if the heat be due to combustion, then the fuel which supports that combustion is, after all, but the sun's rays stored up. If the fuel be, as is now sometimes the case, straw or cotton stalks, one feels that they have been the growth of the one season's effect of the sun's rays. If the fuel be wood, it is equally true that the wood is the growth of a few seasons' exercise of the sun's rays, but if it be the more potent and more general fuel coal, then, although the fact is not an obvious one, we know that coal also is merely the stored up result of many ages exercise of solar power.

And even in the case of electrical prime movers, these depend on the slow oxidation, that is burning, of metal which has been brought into the metallic or unburnt state from the burnt condition (or that of ore) by the aid of heat generated by the combustion of fuel.

The interesting lecture-room experiment with glass tubes charged with sulphide of calcium, or other analogous sulphides, makes visible to us the fact that the sun's rays may be stored up as light; but that they are as truly stored up (although not in in the form of light) in the herb, the tree, and the coal we also now know; and we appreciate the far-seeing mind of George Stephenson who astonished his friend by announcing that a passing train was being driven by the sun. We know that Stephenson was right, and that the satirical Swift was wrong when he instanced as a type of folly the people of Laputa engaged in extracting sunbeams from cucumbers. The sunbeams were as surely in the cucumbers as they are in the sulphide of calcium tubes, but in the latter case they can be seen by the bodily eye, while in the former they demand the mind's eye of a Stephenson.

Although the sailing of ships and the winnowing of grain must from very early time have made it clear that the wind was capable of exercising a moving force, nevertheless, being an invisible agent, it is not one likely to strike the mind as being fit to give effect to a prime mover, and therefore it is not to be wondered at that prime movers actuated by water are those of which we first have any record, unless indeed the toy steam-engine of Hiero may be looked upon as a prime move anterior to those urged by water. It would appear that in the reign of Augustus water-wheels were well known, for Vitruvius, writing at that time, speaks of them as common implements, but not so common as to have replaced the human turnspit, as we gather from his writings that the employment of men within a treadwheel was still the most ordinary mode of obtaining a rotary force. It would seem, however, that water-wheels driven by the impact of the stream upon pallet boards were employed in the time of Augustus not merely to raise water by buckets placed about the circumference of the wheels, but also to drive millstones for grinding wheat, and Strabo states that a mill of this kind was in use at the palace of the King of Pontus.

(To be continued.)

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, No. 2, 1876.—In the opening paper of this number Dr. Konig describes a series of researches in which he sought to study more closely the phenomena which occur when two sets of sound-waves meet in air; using sources of sound that were entirely isolated and could not act directly on each other, nor in common on a third body; he also chose sources that would give as simple tones as possible. The paper is in four parts, treating, severally, of primary beats and beat-tones, secondary beats and beat-tones, difference-tones and summation tones, and the nature of beats and their action, compared with the action of primary impulses. On the last head he finds, *inter alia*, that beat-tones cannot be explained by the cause of difference and summation tones, and that the audibility of beats depends only on the number and intensity of the primary tones, not at all on the width of the interval. The number of beats and primary impulses with which both may be

perceived as separate impulses is the same; so, too, with the number at which beats and primary impulses pass into a tone. Intermittences of a tone, as well as beats and primary impulses, may pass into a tone, and the periodic maxima of vibration of a tone, when in sufficient number. The beat tone formed by two primary tones must be always weaker than these, though separate beats are stronger than the tones forming them.—In M. Grotrian's researches on the constants of friction of some salt solutions, and their relations to galvanic conductivity, the method for ascertaining the constants was that of observing the oscillations of a suspended disc with attached magnet (under the influence of a neighbouring magnet) in air and in the liquid examined. The observed generally similar course of temperature coefficients for fluidity and galvanic conductivity, with change of concentration, leads the author to conclude that the overcoming of internal friction forms an essential part of the work done by a current in passage through an electrolyte. In the case of chloride of potassium, it is found that the increase of conductivity is almost exactly proportional to the per-centage proportion (in the liquid); and M. Grotrian infers that the chemical changes he conceives generally to occur in chemical constitution of electrolytic molecules, on altering the concentration, do not occur here, but that with varied concentration, at the same temperature, the conductivity is only conditioned by the proportion of salt and the viscosity. With the numbers obtained in the experiments, it is possible to estimate for variously concentrated solutions of a salt, the temperatures for which the constants of friction have some determinate constant value; then to calculate the numbers for the conductivity at this temperature, and inquire according to what law these alter with the concentration. He thus shows that in the case of NaCl, KaCl, $CaCl_2$, and $BaCl_2$, the concentration and the viscosity are the principal factors which determine the amount of the conductivity.—In the next paper M. Wiedemann makes some adverse criticism on the recent researches of some French physicists in the domain of magnetism.—M. Holtz shows that wire-net is very well suited for proving that in the interior of conducting surfaces there is no electrostatic action. In one experiment, a bell-shaped cover, made of the net, is brought down by an insulating handle on an insulated metallic disc connected with an electric machine, and on which stands a pith-ball electrometer. The two balls do not diverge in the least on working the machine; but if the bell be removed, they do so at once. He shows further, how such a bell is like a filter or sieve, holding back the electricity while it affords partial passage to gaseous matter or dust. If a metallic point connected to earth be brought near the electrified bell, the balls are moved, but do not diverge, &c.—Dr. Wichmann studies the properties of doubly-refracting garnets; and we note a paper by Dr. Sohncke on the figures eaten out by dissolving liquids on blocks of rock salt, and Exner's method for producing solution-figures.—There is an account of an interesting inquiry, lately conducted by Dr. W. Siemens, on the velocity of propagation of electricity in suspended wires.

Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire. New Series. Part 2. Pp. 57 to 112.—This part contains several very interesting papers on various points of local geology. Some of the papers will be of use to a wide circle of readers, such as Mr. C. Bird's on the red beds at the base of the carboniferous limestone in the north-west of England, and Prof. Green's on the variations in thickness of the Silkstone and Barnsley coal seams in the southern part of the Yorkshire coalfield, and the probable manner in which these and similar changes have been produced. Mr. Bird considers it better to regard the red beds in question as basement beds of the carboniferous limestone than to attempt to draw any arbitrary line in a series whose members appear so closely linked together. Mr. Tiddeman's concise account of the work and problems of the settle Victoria cave exploration will also be welcome. Five good plates accompany this number of the *Proceedings*.

Bulletin de l'Academie Royale des Sciences, 2 ser. tome 40, No. 12.—M. van Beneden contributes a long paper divided into six chapters on the early stages of the embryological development of mammals. In 1874 M. Beneden published his paper, in which he showed that in Hydractinia spermatozoids are derived from the ectoderm and ova from the endoderm. He suggested that the same law probably applied to vertebrata. Observations supporting his view with regard to Cœlenterata have been made by Koch and Fol, and M. Beneden has made embryological studies on the rabbit. A monograph with plates is promised. This paper is a *résumé*.—On the skeleton of a fossil whale in the museum at Milan, by P. J. van Beneden. Following up the descriptions of Pachyacanthus and Aulocetus already given, M. Beneden proceeds to describe the fossil found in 1806 at Mount Pulgnasco, preserved in the Milan Museum, figured by Cortesi and described by Cuvier. The description is accompanied by a plate, and there are references to fossil whales in the museums at Turin, Florence, Bologna, Parma, and Pisa.—On the period of cold of the month of December, 1875, by M. E. Quetelet.—On the Devonian sandstones of Condroz, in the Basin of Theux, in the basin between Aix-la-Chapelle and Ath, and in the Boulonnais. The paper is illustrated with a folding plate giving nine coloured sections, and its scope is to show that the beds of the different localities mentioned have the same relative stratigraphical relations as at Condroz. All of the subdivisions show a remarkable constancy in their petrological and palæontologica aspects.—On the description of some new birds, by M. Alph. Dubois. They belong to Cyanscitta and Icterus.—The theory of carnivorous and sensitive plants, by E. Morren. The article is a *résumé* of observations that have been made, and is well furnished with foot-notes. The index accompanies this number.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 18.—"Observations on Stratified Discharges by means of a Revolving Mirror, by William Spottiswoode, M.A., Treas. R.S.

In a paper published in Poggendorff's *Annalen*, Jubelband, p. 32, A. Wüllner has described a series of observations made, by means of a revolving mirror, upon the discharge of a large induction-coil through tubes containing ordinary atmospheric air at various degrees of pressure.

Wüllner's observations appear to have been directed rather to the nature of the coil discharge than to that of the stratifications.

For some time prior to the publication of the volume in question I had been engaged upon a series of experiments very similar in their general disposition, but with a somewhat different object in view, viz., the character and behaviour of the striæ; and of these, together with some recent additions, I now propose to offer a short account to the Society.

My general instrumental arrangements appear to have been similar to those of Wullner; in fact, they could hardly have been very different. The tubes were attached to the coil in the usual way, and a contact-breaker of the ordinary form with its own electro-magnet was in the first instance used. For this and some other intermediate forms there was finally substituted a mercurial break (successfully arranged by my assistant, Mr. Ward), the plunger of which works on a cam attached to the axle of the mirror, so that the action of the contact-breaker is regulated by that of the mirror, instead of the reverse as in the former arrangement. With the broader tubes a slit was used; with the narrower this adjunct was less necessary; while with capillary tubes, such as are used for spectrum-analysis, it could be dispensed with altogether.

Striæ, as observed by the eye, have been divided into two classes, viz., the flake-like, and the flocculent or cloudy. Of the former, those produced in hydrogen tubes may be taken as a type; of the latter, those produced in carbonic tubes. But upon examining some tubes especially selected for the purpose, it was found that, while to this apparent a real difference corresponds, a fundamental feature of the striæ, underlying both, was brought out.

The feature in question was this: that the striæ, at whatever points produced, always have during the period of their existence a motion along the tube in a direction from the negative towards the positive terminal. This motion, which I have called for convenience the proper motion of the striæ, is for given circumstances of tube and current generally uniform; and its variations in velocity are at all times confined within very narrow limits. The proper motion in this sense appertains, strictly speaking, to the flake-like striæ only. The apparent proper motion of the flocculent striæ is, on the contrary, variable not only in velocity, but also in direction; and on further examination it turns out that the flocculent striæ are themselves compounded of the flake-like, which latter I have on that account called elementary striæ.

Elementary striæ are in general produced at regular intervals along the tube. The series extends from the positive terminal in the direction of the negative to a distance depending upon the actual circumstances of the tube and current. The length of

the column, and consequently the number of the striæ, depends mainly upon the resistance of the tube, the duration of the entire current, and to a certain extent upon the amount of the battery surface exposed, and in that sense upon the strength of the current. The velocity of the proper motion, other circumstances being the same, depends upon the number of cells employed.

The paper next gave descriptions of the phenomena exhibited by several tubes; and drawings illustrative of the descriptions were added.

The following are some of the general conclusions to which the experiments detailed in the paper seem to lead:—

1. The thin flake-like striæ, when sharp and distinct in their appearance, either are short-lived or have very slow proper motion, or both.

2 The apparent irregularity in the distribution of such striæ during even a single discharge of the coil, is due, not to any actual irregularity in their arrangement, but to their unequal duration, and to the various periods at which they are renewed. The striæ are, in fact, arranged at regular intervals throughout the entire column. The fluttering appearance usually noticeable is occasioned by slight variations in position of the elementary striæ at successive discharges of the coil. With a view to divesting the coil discharge of this irregular character, as well as for other purposes, I devised two different forms of contact breakers (one of which is described in the Royal Society's *Proceedings*, 1874); but I postpone a description of the second, as well as of the experiments arising from its use, to another occasion.

3. The proper motion of the elementary striæ is that which appertains to them during a single discharge of the coil. This is always directed from the positive towards the negative terminal. Its velocity varies generally within very narrow limits. It is greater the greater the number of coils employed. In some tubes it may be seen to diminish towards the close of the discharge, and even in rare instances alternately to increase and to diminish during a single discharge.

4. Flocculent striæ, such as are usually seen in carbonic acid tubes, are a compound phenomenon. They are due to a succession of short-lived elementary striæ, which are regularly renewed. The positions at which they are renewed determine the apparent proper motion of the elementary striæ. If they are constantly renewed at the same positions in the tube, the flocculent striæ will appear to have no proper motion, and to remain steady. If they are renewed at positions nearer and nearer to the positive terminal, the proper motion will be the same as that of the elementary striæ; if they are renewed at positions further and further from the positive terminal, the proper motion will be reversed.

5. The velocity of proper motion varies, other circumstances being the same, with the diameter of the tube. This was notably exemplified in the conical tube. In tubes constructed for spectrum analysis the capillary part shows very slight, while the more open parts often show considerable proper motion.

6. Speaking generally, the discharge lasts longer in narrow than in wide tubes. In spectrum tubes the capillary part gives in the mirror an image extending far beyond that due to the wider parts.

7. The coil discharge appears, in the earlier part of its development at least, to be subject to great fluctuations in extent. In all cases there is a strong outburst at first. This, although sometimes appearing as a bright line, is always, I believe, really stratified. Immediately after this there follows a very rapid shortening of the column. The extent of this shortening varies with circumstances; but when, as is often the case, it reaches far down towards the positive terminal, a corresponding diminution of intensity is perceptible in the negative glow. The column of striæ, after rising again, is often subject to similar fluctuations. These, which are sometimes four or five in number, are successively of less and less extent, and reach only a short distance down the column or striæ. The rifts due to these fluctuations then disappear, and the striæ either continue without interruption, or follow broken at irregular intervals, until the close of the discharge.

8. The effect of the proper motion, taken by itself, is to shorten the column of striæ. But, as we have seen, the striæ are in many cases renewed from time to time. In regard to this point, the head of the column presents the most instructive features. After the cessation of these rifts, the general appearance of the field is that of a series of diagonal lines commencing at successive points which form the bounding limit of the column at successive instants of time. If the points are situated in a horizontal line, the striæ are renewed at regular intervals at the same place; and the length of the column is maintained by a periodic renewal of striæ, a new one appearing at the head of the column as soon as its predecessor has passed over one dark interval. If the boundary of the illuminated field rises, the length of the column increases; if it descends, the column shortens. In every case, however, the growth of the column takes place by regular and successive steps, and not irregularly. The intervals of the new striæ from one another and from the old ones are the same as those of the old ones from one another.

9. The principal influence of a change in the number of cells used appears to consist in altering the velocity of proper motion. A change in the amount of battery-surface exposed produces a corresponding change in the duration of the entire discharge, as well as apparently in the development of some of the minor details of the striæ.

10. When the proper motion of the elementary striæ exceeds a certain amount, the striæ appear to the eye to be blended into one solid column of light, and all trace of stratification is lost. When this is the case the mirror will often disentangle the individual striæ. But there are, as might well be expected, cases in which even the mirror is of no avail, but in which we may still suppose that stratification exists. A variety of experiments have led me to think that the separation of the discharge into two parts, viz., the column of light extending from the positive terminal, and the glow around the negative, with a dark space intervening, may be a test of stratified discharge; but I cannot affirm anything certainly on this point.

Chemical Society, May 18.—Prof. Abel, F.R.S., president, in the chair.—The first paper read was on the action of malt extract on starch, by Mr. C. O'Sullivan, showing that under these circumstances it is converted into a mixture of maltose and dextrin, the proportion of which varies with the temperature at which the reaction takes place.—A communication was then made by Dr. H. E. Armstrong and Mr. Gaskell on metaxenol, the metadimethylated phenol.—There were also papers on the gases enclosed in cannel coals and in jet, by Mr. J. W. Thomas, on phenomena accompanying the electrolysis of water with oxidisable electrodes, by Dr. J. H. Gladstone and Mr. A. Tribe, and on the estimation of hydrogen occluded by copper, with special reference to organic analysis, by Dr. J. L. W. Thudichum and Dr. H. W. Hake.

Meteorological Society, May 17.—Mr. H. S. Eaton, president, in the chair.—James Lloyd Ashbury, John Broun, John Brown, Edmund Cruise, James Eldridge, George Garnett, John Hopkinson, Robert Pickwell, William Ford Stanley, Rupert Swindells, Charles Tarrant, Thomas Taylor Smith, were elected fellows of the Society. The following papers were read:—Remarks on the present condition of maritime meteorology, by Robert H. Scott, F.R.S. This paper gives a history of all that has been done in maritime meteorology since the Brussels conference in 1853, up to the present time.—In the mean temperature of every day at the Royal Observatory, Greenwich, from 1814 to 1873, by James Glaisher, F.R.S. This paper, which is a continuation of former ones on the same subject, contains the observations for the ten years, 1864 to 1873, which being combined with the previous ones, give the mean for sixty years. On the meteorology of Mozufferpore, Tinhoot, for 1875, by C. H. Pearson.—New wind chart, by Lieut.-Col. G. E. Bulger.

Physical Society, May 13.—Prof. G. C. Foster, president, in the chair.—The following candidates were elected members of the Society:—Prof. T. Andrews, Rev. R. H. M. Bosanquet, M.A., and David Howard.—Mr. Thompson, B.A., B.Sc., concluded the communication on the supposed new force, which he commenced at the last meeting of the Society. In the arrangement which he has adopted for obtaining the spark, the secondary current of a Rhumkorff's coil is made to traverse a short coil of wire which is thoroughly insulated from the internal core, and into the circuit an arrangement is introduced by means of which the current may be made to traverse a variable thickness of air in its course round the short coil. It is found that if this spark is very short the spark obtained from the internal core is also short, but as we increase the thickness of air to be traversed, the spark which may be drawn off increases; the greatest effect, however, is produced when one terminal of the coil is connected with the earth, the spark then obtained being about half an inch in diameter. Mr. Edison considered that the spark was retro-active, but Mr. Thompson showed, by an experiment,

that deficient insulation might lead to such a conclusion. He then proceeded to show that just as the charge given to a gold-leaf electroscope is at times positive and at times negative without any apparent reason for the change, so if the core of the arrangement employed be connected with a Thomson's galvanometer, the needle will be found to wander irregularly about the scale on both sides of the zero. In order to show that these experiments are identical with those conducted as originally described by the discoverer, the terminals of the induction coil were connected with the coil of an electro-magnet, the same means of including a layer of air in the circuit being introduced. The effect in this case was found to be precisely similar to that obtained with the special arrangement previously used; with a brush discharge a Geissler's tube could be illuminated, and, when the layer of air was infinitesimal, the spark produced was also infinitesimal. It was then shown that, if the spark at the point of contact in the key when a direct battery current traverses the coil be done away with by shunting the extra current which gives rise to it, no spark can be obtained from the core. It thus appears that no spark is obtained when there is no necessity for an inducing current to accumulate until it has sufficient tension to leap over a resisting medium, and that, as the thickness of this resisting medium increases, the spark obtained becomes greater. Evidently on these occasions the current has time to attract unlike and repel like electricity in the core, and if a conductor in connection with the earth be presented to this core, the like electricity will escape; hence a spark will result. As soon, however, as the tension has become sufficient to leap over the layer of air, it will be necessary to restore equilibrium in the core. Hence there will be a return spark in the opposite direction. From these experiments it will be seen that the phenomena observed may be explained by the ordinary laws of induction.

Institution of Civil Engineers, May 23.—Mr. Abernethy, vice-president, in the chair.—The paper read was on the permanent way of railways, by Mr. R. Price Williams.

CAMBRIDGE

Philosophical Society, May 8.—Mr. W. M. Hicks drew attention to some experiments of Messrs. Stewart and Tait on the heating of discs by rapid rotation in vacuo, and which they referred to the friction of the ether. It was shown that it was not necessary to have recourse to this explanation; that nearly all the effects could be accounted for if it is supposed that the disc, through the rapid rotation, has expanded and consequently been lowered in temperature; that whilst rotating it is raised to the temperature of the surrounding region; and therefore when the rotation is stopped, and the disc has shrunk to its former size, it will give out the heat it had taken in whilst rotating. In the case of silver it was shown that the disc ought to show a rise of ·4° C. if the rotation had been continued for some time, and this was compared with the rise of ·47° C. which Messrs Stewart and Tait had observed in an aluminium disc, thus showing that the effect was of the same order of magnitude in the two cases. It was also shown that if the whole heating were due to ethereal friction, that this friction would be ·0006 lbs. per square foot, and that if we suppose this amount to act on the surface of the earth, the day would be lengthened in the course of a century by something like ·006".—Prof. Maxwell afterwards made a communication on the equilibrium of heterogeneous substances.

STOCKHOLM

Royal Academy of Sciences, Feb. 9.—Herr Gyldén communicated a transformation of the formula—

$$\left\{1 + 2l_1 \operatorname{Cos}\left[2\, am \frac{2K}{\pi} + \Lambda\right] + l_1^2\right\}^{-\frac{n}{2}}$$

which plays an important *rôle* in the method of deducing a general formula of perturbation for periodic comets worked out by him. This transformation is mainly grounded on the relation—

$$e^{\sqrt{-1}\, am \frac{2K}{\pi}} = e^{\sqrt{-1}\, x} \frac{\eta(-x)}{\eta(x)},$$

where

$$\eta(x) = \left(1 - q e^{2\sqrt{-1}x}\right)\left(1 - q^3 e^{-2\sqrt{-1}x}\right)\left(1 - q^5 e^{2\sqrt{-1}x}\right)$$

and upon certain algebraic relations between different η-functions.

The final result is specially applicable when a comet comes to that part of its path which lies nearest the perturbing planets; in this case l becomes inconsiderably less than 1, and Λ may be taken to fall within exceedingly narrow limits in the neighbourhood of 0. The following papers were given in:—Myriopoda from Siberia and Waigat's Island, collected during Nordenskjold's expedition, 1875, by Anton Stuxberg. Eighteen species are described, of which only one was previously known to exist in Siberia, and fifteen are new to science, viz.—Lithobius 10, Iulus 1, Polydesmus 2, and Craspedosoma 2. Of the twenty-seven Siberian species now known only two are European.—Determinations of geographical position during the Swedish expedition to Novaya Zemlya and the Kara Sea, 1875, calculated by E. Jaderin.—On monœcism in fishes, by A. W. Malm.—Prof. Borenius communicated magnetic observations made at Helsingfors simultaneously with those made by the Swedish expedition at Spitzbergen during the winter 1872–3.

BERLIN

German Chemical Society, May 8.—A. W. Hofmann, president, in the chair.—E. Schunck and H. Römer by fusing Anthraflavinic and isoanthraflavinic acids with potash, have obtained two isomeric purpurines $C_{14}H_8O_5$. Anthrapurpurine is identical with a substance formerly obtained by Mr. Perkins; flavopurpurine obtained from the second of the two substances is the fourth isomeric purpurine.—A. Boettinger in studying anew the decomposition of tartaric acid by heat, believes that the formation of pyruvic acid is preceded by that of glyceric acid.—Dr. T. Stenhouse and C. E. Groves in treating pure naphthaline with sulphuric acid, obtained not only β-naphthaline-sulphurous acid, but also two napthaline-sulphones $C_{20}H_{14}So_2$, easily separated by sulphuret of carbon. They yield by oxidation two isomeric naphthaline-sulphuric acids.—T. Annaheim described dibromonitrooxysulphobenzid $(C_6H_2BrNO_2OH)_2SO_2$ and the corresponding iodo-compound. The same chemist described a red colouring substance obtained by the action of fuming sulphuric acid on cresol.—W. Rimarenko described β-chloronaphthaline obtained from β-naphthol and from β naphthaline-sulphuric acid with PCl_5,—the method formerly described by M. Clare.—E. v. Gorup Besancy and H. Will have investigated the liquid secretion of insectivorous plants (Nepenthes phyllaniphera). Albumine, fibrine, &c., are transformed into peptone. This digestion takes place in a very short time, when the secreting organ of nepenthes has been excited by contact,—the liquid having under these circumstances an acid reaction. The secretion of non-excited glands is rendered equally active by the addition of any acid, particularly of malic and citric acids.—H. Vogel published researches on the influence of different rays of light on bromide' of silver.—F. Tiemann and N. Matsnold have prepared nitro-protocatechic acid and some of its derivatives, also nitro-vanillinic acid and acetyl-nitro-vanillinic acid.—F. Tiemann and C. Reimer have obtained paraoxybenzoic aldehyde by treating phenate of potassium with chloroform.—E. Hoffmann described derivatives of hesperidine, particularly an acid $C_{10}H_{10}O_4$, which with potash yield protocatechic acid.

CONTENTS

THURSDAY, JUNE 15, 1876

BRITISH MANUFACTURING INDUSTRIES

British Manufacturing Industries. By Various Authors. Edited by G. Phillips Bevan. (London: Edward Stanford.)

IN this series we have presented to us an account of the origin and development of those industries which have given this country her pre-eminence among nations. As stated by the editor, the object of the various treatises is simple and unambitious; no attempt is made to render them technical guides to the industries to which they relate; the main idea is to give, in as readable a form as is compatible with accuracy and a freedom from superficiality, the main features and present position of the leading industries of the kingdom, so as to enable general readers to comprehend the enormous growth of the last quarter of a century. The editor has been singularly fortunate in the selection of his co-operators. For example, Prof. Warington Smyth tells us all about the mines and collieries of the country; Prof. Hull discourses on quarries and building stones; Capt Bedford Pim on shipbuilding; Mr. Mattieu Williams finds congenial themes in iron and steel, gunpowder and explosives. The article on cotton by Mr. Isaac Watts, the Secretary of the Cotton Supply Association, is remarkably full and complete; Mr. Felkin's little treatise on hosiery and lace is a perfect mine of information, and forms a most interesting record of perseverance and effective skill; the stories of Jedediah Strutt and John Heathcoat will ever be two of the most thrilling chapters in the history of the industrial progress of this country. Indeed this series might have been fitly called the Romance of British Industry. We are told of Lee and the stocking-frame; of Wedgwood and Herbert Minton; of Hargreaves, Arkwright, and Crompton; of Dud Dudley and poor Cort; and of numbers of others, whose peaceful victories have done more for this country than all the machinations of her statesmen or the valour of her armies. *Apropos* of the invention of the stocking-frame it may be remarked that Elmore's well-known picture, representing Lee, after his expulsion from his college, intently watching the lissom fingers of his wife as she knits for the support of the household, in order that he might imitate their motion, is founded on a myth. Lee was a decent country curate in easy circumstances; he was never married, nor was he expelled from his college. But little is known of his history, beyond that, becoming greatly discouraged with the reception of his invention in this country, he passed over to France, where he died, neglected and in misery, in 1610. The history of the improvement of the stocking-frame is not less interesting than that of its origin. Since the time of Strutt, nearly 300 changes and adaptations have been patented, the vast majority of which are due to men who commenced life at the forge or bench, or at the frame itself.

The history of the rise and development of the lace manufacture is scarcely less remarkable, and Mr. Felkin has much to say concerning the personal history of its founders and of the trials and struggles of the inventors and improvers of lace-making machinery. Few trades have probably given rise to such an amount of litigation: indeed one can have no real conception of the immensity of the barrister's theme, or how eloquent he must have seemed to the beaver when—

> "he proceeded to cite
> A number of cases where the making of laces
> Had proved an infringement of right."

until he has read this essay. The story is painfully sad, and its moral is not lost on Mr. Felkin. "We cannot but remark," he says, "the extraordinary amount of latent inventive skill brought into operation by men entirely uninstructed in the science of mechanics; and be struck with the time and thought that the knowledge of sound mechanical principles would have saved them. . . . It is painful to notice how many of these men, possessing fine natural talents, from the want of self-government failed to use aright even the measure of profit that reached them. . . . Genius was to them rather a curse than a blessing. Here are strong arguments for higher scientific and moral education to be placed within reach of these classes."

Mr. Mattieu Williams concludes his capital little treatise on steel with a similar reflection. He indignantly protests against the fallacy of attributing our industrial success to coal or iron-stone, or to any other mere mineralogical or geographical accident. "It is not British minerals, but British industrial energy which has given us our industrial supremacy. It is not true that we are so exceptionally rich in coal. Many other nations possess vastly greater stores than ours; but while theirs has lain buried under their feet, ours has been brought to the surface and wonderfully used; to such an extent indeed, that we are actually approaching the limits of our supply before other and older people have tapped theirs. . . The same energies which have thus seized upon and utilised the rudest source of power to supply the coarser wants of ourselves and the rest of mankind, will if properly directed, similarly turn to account the more refined and recondite energies of nature which science is revealing, and which will supply in like manner the higher wants of more advanced civilisation. To succeed in this we must prepare at once, by affording to all classes the largest attainable amount of knowledge of the raw materials and powers of nature; of human means of turning these to profitable account; of the social organisation in the midst of which we live, and by which we are to co-operate industrially with each other and all the peoples of the earth; and above all, of the individual moral qualities, habits, and attainments that are necessary for each man's industrial success."

It is because other nations are actually turning to account "the more refined and recondite energies of nature" that our industrial supremacy is threatened. In chemical manufacturing, for example, the pre-eminence of the alkali trade belongs to us, but, as Prof. Church tells us, German, Austrian, and French manufacturers are far ahead of us in the production of the finer and more delicate preparations of the chemist, and still continue to make remarkable progress. "If a rare and curious substance, discovered by a scientific chemist and made in his laboratory painfully grain by grain, be found useful in medicine or dyeing, or some other art, straightway the foreign manufacturing chemist makes it, not by the ounce or pound merely, but by the hundredweight or

even by the ton." Much of the crude material which yields these beautiful and costly products of the continental manufactories is exported from England to be worked up and reimported. The reason of this lies in the more intimate union of science and manufactures which prevails abroad. The chemical manufacturer on the continent finds it to his interest to attach a sound and properly-trained chemist to his works to improve the established methods of production and to seek to discover new processes.

With the space at our disposal it is impossible to do more than merely indicate the scope and character of this series of excellent treatises. There are one or two little matters which need revision, and which the editor will doubtless set right in future editions: for example, the combining proportion of tin is not usually stated as 58, nor that of zinc as 32·6. Perhaps the most serious drawback is the very sparing use of illustrations. When given they are generally very good; nothing could exceed the beauty and finish of the cuts accompanying Mr. Watts' article on cotton. We are sorry that the example thus set has not been more generally followed. T.

HUTTON'S "GEOLOGY OF OTAGO"

Report on the Geology and Gold-fields of Otago. By F. W. Hutton, F.G.S., Provincial Geologist, and G. H. F. Ulrich, F.G.S., &c. (Dunedin: Mills, Dick, and Co.; London: Sampson Low and Co., 1876.)

THE Southern Province of New Zealand is one of great interest from the variety of its physical features which faithfully indicate the wide range of geological formations of which it is built up. The snow-clad ridge of "The Southern Alps," with numerous pointed peaks and serrated ridges, runs along the western coast, and is penetrated by deep "sounds," or fiords, not unlike some of those on the west coast of Norway. Mount Aspiring, at the northern border of the province, reaches an elevation of 9,940 feet, while several other points rise upwards of 8,000 feet above the sea, forming altogether a grand background, from which the rest of the country descends towards the eastern coast in a series of rolling downs, diversified by deep valleys and numerous lakes. The rivers are remarkable for, in several cases, and with much perversity, cutting through ridges, and crossing the boundaries of the formations, in a way that not long ago would have been attributed to the effects of mighty "convulsions of Nature," but which the physical geologist is now able to account for on very different principles. The Southern Alps contain glaciers which, as Mr. Hutton shows very clearly, extended considerably beyond their present bounds on two occasions in later Tertiary times, and to this agency he refers the excavation of the rock basins which now constitute nearly all the lakes of the hilly districts. An excellent view of this chain of snowy mountains will be found in Dr. von Hochstetter's elaborate work on New Zealand; in which Mount Cook, Mount Tasman, and the adjacent mountain giants are seen towering to an elevation of 13,200 feet above the waters of the ocean.

The work before us is a very carefully prepared, and scrupulously accurate, report on the physical features and geological structure of the district of Otago which, under the direction of Dr. Hector, the author has explored and mapped. The arrangement of the matter is good, and the descriptions succinct, while the writer is careful to notice the labours of others in the same field of research. The roughness of some of the woodcut illustrations, which one cannot fail to notice, is perhaps inseparable from a work brought out in a young colony, and is not to be laid to the charge of the author.

As already observed, the geological formations of Otago have a wide range in time, extending from the crystalline masses of the New Zealand Alps (possibly referable to the Laurentian period) through the representatives of the Lower Silurian, Carboniferous, Triassic, Jurassic, Cretaceous, and Tertiary times down to the present day. The thickness of some of these older formations is doubtless very great, but the difficulty which the author feels in estimating the apparent thickness of some of these formations at the amount deduced from the dip of the beds may probably be overcome by supposing that the beds are folded over on themselves—a phenomenon of very common occurrence in such districts as that of the New Zealand Alps. The Otago formations have very properly received names derived from localities where they are well represented. The reference to the equivalent formations in Europe is given with some hesitation; nevertheless, it cannot be doubted that on the whole these determinations are substantially correct—even if we suppose a relative, rather than an absolute, synchronism owing to the vast intervening space between Europe and New Zealand; and for all purposes of comparison it is not of the slightest importance whether it is one or the other.

The great oscillations of level through which New Zealand has passed are well described and illustrated by Mr. Hutton under the head of "Historical Geology." These correspond to some extent with the movements which in Britain and Europe have enabled us to define the limits of the three great divisions of geological time. Towards the close of the Palæozoic period "New Zealand probably formed a subordinate part of a large continent, which, judging by the similarity of the shells and plants, joined in the following formations with those of Australia, India, and Europe, probably stretched far away to the northward" (p. 75).

At the commencement of the Triassic period this continent began in New Zealand to be submerged; and with one or more slight oscillations this subsidence continued till towards the middle of the Jurassic period, when the whole country was again elevated, and the chain of the New Zealand Alps was formed. Great denudation of the upraised beds ensued, as they remained exposed to the atmosphere till the later Cretaceous period. Hence the unconformity between the Upper Cretaceous and the Lower Jurassic rocks (the Warpara and Putataka formations), and the entire absence of the intervening strata. Since the great upheaval here referred to, the New Zealand Alps have never been totally submerged, though sometimes deeply depressed.

The Upper Cretaceous period was one of submergence to all but the higher elevations, and at its close there was another elevation, accompanied by disturbances of the strata, resulting in an unconformity between the Tertiary beds and all those of older date. These former are found

filling in the depressions and old valleys of the Mesozoic and Palæozoic rocks, and often containing valuable beds of lignite resulting from the decay of the vegetation which found a congenial soil and climate amongst the lakes and lagoons of the period.

Mr. Hutton considers that there was a "Glacier period" during older Pliocene times, and another of less importance just before the Pleistocene epoch. Both of these are of earlier date than "The Glacial period" of the northern hemisphere, and in the view of the author, as well as of Dr. von Hochstetter and Dr. Haast,[1] were due not to climatical influences extending over the southern hemisphere and differing from those of the present day, but solely to the greater elevation of the land in New Zealand at those periods, and the consequent extension of snow and ice over a larger area than at present.

In Mr. Hutton, "The Theory of the Glacial Origin of Lakes," at least as far as it applies to the province of Otago, finds a new and welcome advocate; and his observations on this question are opportune at this time, as Prof. Ramsay's theory has been challenged by an able writer in the pages of the *Geological Magazine*.[2] Mr. Hutton first examines the views of those who have referred the origin of these lakes in Otago to subsidences, or terrestrial movements, and considering them inadequate, falls back on that of glacial erosion, in support of which he can appeal to the evidence of former glacial action along the shores of the lakes themselves.

The latter portion of the volume before us is taken up with the report of Mr. Ulrich upon the gold-fields of Otago, which is of much local interest, and will doubtless prove of value in guiding future adventurers, but does not appear to call for special observation in a short review.

OUR BOOK SHELF

Elementary Algebra, with Numerous Exercises, for Use in Higher and Middle-class Schools. By David Munn, F.R.S.E. (Collins' School Series, 1876.)

THE chief justification, perhaps, for the production of this work is that the exigencies of a "school series" demanded the publication of an elementary algebra. There is not much more in it than is to be found in a half-dozen similar works, and the explanations of rules seem to us to fall short of those given elsewhere. We do not like the frequent use of *evidently* in an elementary work; our own extended experience with English schoolboys is that these elementary details are by no means evident to the ordinary schoolboy mind. On p. 70 "the L.C.M. of a^3b^2c and $a^2b^3c^2$ will evidently be $a^3b^2c^3$" is evidently wrong, for it evidently ought to be $a^3b^3c^2$. Art. 8 on p. 45 (to show that when a certain algebraical polynomial is divided by $(x-a)$, the remainder is what the polynomial becomes when in it x is changed to a) is useful, and we teach it to advanced pupils, but we are disposed to think that few beginners could grasp the truth and apply it. On pp. 173 to 176 we have some interesting *Miscellaneous Propositions* on the progressions which we do not remember to have seen in previous textbooks. The most important mistakes we have found are on pp. 66, 96, 107, 151, 153. Here we may remark that there is a very plentiful crop of typographical blunders; many of these we are disposed to attribute to a hasty examination of the "proofs;" frequent instances, too, occur in which 2, 3, or 5 have got interchanged. There is a large collection of exercises, but happily no answers are given at the end, or the list of errata would doubtless have been greatly enlarged. From the fact that $(a^m)^n = (a^n)^m$ for positive integers, "it follows that $(a^{\frac{p}{q}})^q = a^p$." This, we think, will hardly be admitted; we should prefer to assume that the result holds, and thence derive an interpretation of $a^{\frac{p}{q}}$. The book takes in Indeterminate Equations, Permutations, Ratio, Proportion, Variation, and the Binomial Theorem. The only Scoticism we have noticed is one that frequently occurs: it is, "we will find," &c.

[1] See Hochstetter's "New Zealand," English translation, p. 504.
[2] No. 139, January 1867. The statements of Mr. Judd have called forth several rejoinders in the ensuing number of the *Magazine* for February.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Early History of Magnetism

PERMIT me to supplement "K.'s" excellent sketch of the "History of Magnetism" (NATURE, vol. xiii. p. 523) by two notices of the "Mariner's Compass," which seem to be of earlier date than any hitherto found in Europe. They possess particular interest from showing the compass in so rude a state as to lead to the inference that we owe it to a re-discovery rather than to an importation from China. The author of the notices is Alexander Neckam, an English writer of the twelfth century, and they are now included in a book which was privately printed in 1857, entitled "A Volume of Vocabularies," illustrating the condition and manners of our forefathers from the tenth to the fifteenth century, edited from MSS. in public and private collections, by Thomas Wright, M.A., F.S.A., Hon. M.R.S.L., &c. It was through the zeal and the liberality of Joseph Mayer, F.R.A.S., F.S.A., of Bebington, that these notices were brought to light, and a most useful volume was produced, of which he bore the charge.

As the discovery was made by Mr. Wright, it shall be reported in his own words. In referring to the many points of interest upon which new light is thrown by the vocabularies, he says:—

"None of these, perhaps, is of more importance than the curious early allusion to the use of the mariner's compass by the navigators of the western seas. It is well known to all readers that this invaluable invention has been formerly supposed to have been brought from the East, and not to have been known in the West until the fourteenth century, when it was used by the Italian mariners. Allusions to it have, however, been discovered by the students of mediæval literature in works which date as far back as the thirteenth century. In the following pages we find this invention not only alluded to in the twelfth century, but described in such a manner as to show that it was then absolutely in its infancy, and to leave little doubt of its having originated in the West. Alexander Neckam, in his treatise 'De Utensilibus,' enumerates among the ship's stores a needle which was placed on a pivot, and when turned round and left to take its own position in repose, taught the sailors their way when the polar star was concealed from them by clouds or tempest. I have discovered and printed in the note to this passage, a passage in another of Neckam's works, the inedited treatise 'De Naturis Rerum,' which gives a more distinct account of this invention. 'Mariners at sea,' he says, 'when through cloudy weather in the day which hides the sun, or through the darkness of the night, they lose the knowledge of the quarter of the world to which they are sailing, touch a needle with the magnet, which will turn round till, on its motion ceasing, its point will be directed towards the north.' A comparison of these two passages seems to show pretty clearly that at this time the navigators had no regular box for the compass, but that they merely carried with them a needle which had been touched with the magnet (perhaps sometimes they carried the magnet also, and touched the needle for the occasion), and that when they had to use it they merely placed it upon some point, or pivot, on which it could turn with tolerable freedom, and then gave it a motion, and waited until it ceased moving. This mode of

using the needle was, it must be confessed, rude enough. The passage in the treatise 'De Utensilibus' contains one particular which is very obscure, as Neckam informs us that when the needle ceased moving it pointed towards the east (*donec cuspis acus respiciat orientem*), and as all the manuscripts agree in this reading, and it is glossed by *est*, this must be the intention of the writer I know no way of explaining this, unless it be by the supposition that as in the twelfth century, the East was the grand object of most voyages from this part of the world, an attempt had been made to improve the magnetic needle, by adding to it a limb at right angles, which should point to the east when the needle itself pointed to the north, and that this was what Neckam called the *cuspis acus* Between this and the date—whatever it may be—of the poem, also quoted in my note on the passage of Neckam, which contains the first allusion to the mariner's compass in the thirteenth century, an attempt had been made to facilitate its use [1] This was done by thrusting the needle through some substance which would not sink, and placing it upon the surface of water Guiot de Provins, the author of the poem alluded to, calls this substance a *festu*, a stick or straw (the Latin *festuca*) The mariners, he tells us, have a contrivance depending on the magnet, which cannot fail The magnet, he adds, is an ugly brownish stone, to which iron is attracted 'After they have caused a needle to touch it, and placed it in a stick, they put it in the water, without anything more, and the stick keeps it on the surface Then it turns its point towards the star with such certainty that no man will ever have any doubt of it, nor will it ever for anything go false When the sea is dark and hazy, that they can neither see star nor moon, they place a light by the needle, and then they have no fear of going wrong, towards the star goes the point, whereby the mariners have the knowledge to keep the right way It is an art which cannot fail' According to another poet, the substance through which the needle was usually thrust was cork He tells us that 'the mariners who went to Friesland, or to Greece, or Acre, or Venice' were guided by the polar star, but when at night, or in obscure weather, it was invisible, they discovered its position by the following contrivance - 'They thrust a needle of iron through a piece of cork, so that it is almost buried in it, and then touch it with the loadstone, then they place it in a vessel full of water, so that no one pushes it out until the water is calm, for in whatever direction the point aims, there without doubt is the polar star' The MS in which this latter poem was found is undoubtedly of the fourteenth century, but the poem itself is evidently of somewhat older date of the beginning of that century, or not improbably of the century preceding It is possible therefore that this rudely constructed mariner's compass may have continued unimproved until the fourteenth century" [2] (*Introduction*, pp 16 18)

[1] In this interval we meet with another slight but very curious allusion to the use of the magnetic needle for the purposes of navigation Jacques de Vitri, one of the historians of the Crusades who wrote about the year 1 18 says ("Hist Hieros, cap 89) — Acus ferrea, postquam adamantem contigerit, ad stellam septentrionalem, quæ velut axis firmamenti aliis vergentibus non movetur, semper convertitur unde valde necessarius est navigantibus in mari'

[2] This very curious poem, a sort of song, is preserved in a manuscript formerly in the collection of M Barrois of Paris, and now in that of Lord Ashburnham It was first pointed out by M Fr Michel, who printed the portion relating to the mariner's compass in the preface to his 'Lais Inedits (Paris, 1836) As this is now a rare book, I have thought it desirable to give here the whole passage as a complement to the extracts given in the note on p 114 of the present volume It is as follows —

"I a tresmontaigne est de tel guise
Qu'ele est el firmament assise
Ou ele luist et reflambie
Li maroniers qui vont en Frise,
En Grese en Acre ou en Venisse,
Sevent par li toute la voie
Pour nule riens ... se de voie,
Tout jours se tient en une more
Tant est de li grans li servisse,
Se la mers est enflee ou koie
Jà ne sera c on ne le voie,
Ne pour galerne ne pour bise

Pour bise, ne pour autre afaire
Ne laist sen dout servise à faire
La tresmontaigne clere et pure,
Les maroniers par son esclaire
Jete souvent hors de contraire,
Et de chemin les asseure
Et quant la nuis est trop oscure,
S est ele encor de tel nature,
Qu al aimant fait le fer traire,
Si que par forche et par droiture
Et par ruille qui tous jours dure,
Sevent le liu de son repaire,
Son repaire sevent a route,
Quant la nuis n a de clarte goute,
Tout chil qui font cest maistrise,
Qui une aguille de fer boute
Si qu ele pert presque toute
En i poi de liege et l atise
A la pierre d aimant bise
En i vais el plain d yave est mise,
Si que nus hors ne la deboute,
Si tost com l iave s iserise,
Car dons quel part la pointe vise,
La tresmontaigne est la sans doute"

The following is the text of Neckam with the interlinear gloss:—

ille une pere faut naute
"Qui ergo vult habere navem, albestum habeat, ne desit ei
fu aguyl mis
beneficium ignis [1] Habeat etiam acum [2] jaculo suppositam,
turne e enurun aguyl poynt agardet
rotabitur enim et circumvolvetur acus donec cuspis acus respiciat
est tal modo i ubi mariners
orientem, sic que comprehendunt quo tendere debeant naute cum
cinossura" [the cynosure, κυνόσουρα, or constellation popularly
atapist de leyr tempeste cinossura
called Charles's wain] "latet in aeris turbacione, quamvis ad
achecement circle petit
occasum nunquam tendat propter circuli brevitatem." ("De Utensilibus," p 114)

Mr Wright adds "The earliest account of the mariner's compass, before known, was contained in the following lines of a satirical poem, entitled the 'Bible Guiot de Provins,' composed in the thirteenth century (Barbazan, "Fabliaux," tom ii p 328)

" Un art font qui mentir ne puet
Par la vertu de la maniete,
Une pierre laide et brunete,
Ou li fers volontiers se joint
Ont si esgardent li droit point
Puis c une aguile i ont touchie,
Et en un festu l ont couch
En l eve le metent sanz plus
Et li festuz la tient desus
Puis se torne la pointe toute
Contre l estoile si sanz doute,
Que jà nus hom n en doutera,
Ne jà por rien ne fausera
Quant la mers est obscure et brune,
C on ne voit estoile ne lune,
Dont font a l aguille alumer,
Puis n ont il garde d esgarer
Contre l estoile va la point
... ont li mariner cointe
De la droite voie tenir
C est uns ars qui ne puet faillir

The language of the last extract fully bears out Mr Wright's estimate of it as not earlier than the thirteenth century

WM CHAPPELL

The Dry River beds of the Riviera

MR H T. WHARTON's letter (NATURE, vol xiii, p 448) does not seem fully to explain the difficulty expressed by Mr R. I Bartlett (NATURE, vol xiii, p 406), a difficulty which is often felt by many of the visitors to the Riviera Mr Wharton is quite correct with regard to the Paglione This stream has, I believe, within the last few years been often in high flood, and has been more than once within a foot or two of the top of the arches of the bridge which Mr. Bartlett seems to think is unnecessarily large The Paglione, where it passes through Nice, is not, however, a fair representative of the river-beds of the Riviera. When the river walls were built, which now retain the Paglione, the river bed was, in all probability, made much narrower than it previously was, on account of the value of the land for building purposes, and only so much of the river-bed retained as was necessary to carry away the water, so that the Paglione now completely fills its channel when in flood This is far from

[1] It was believed that the asbestus, when once lighted, could never be extinguished, and hence Neckam recommends it to be carried on shipboard, that the sailors may never be without fire

[2] This rather obscure description of the mariner's compass, belonging certainly to the twelfth century, is the earliest allusion to the use of that important instrument in the middle ages Alexander Neckam has, however, given a rather fuller description of it in another of his books, the treatise "De Naturis Rerum, lib 2, c 89 (MS Reg. 12 G xi, fol 53 v°). "Nautæ etiam mare legentes, cum beneficium claritatis solis in tempore nubilo non sentiunt, aut etiam cum caligine nocturnarum tenebrarum mundus obvolvitur, et ignorant in quem mundi cardinem prora tendat, acum super magnetem ponunt, quæ circulariter circumvolvitur usque dum, ejus motu cessante, cuspis ipsius septentrionalem respiciat." [Here the error about pointing to the east is corrected]

being the case with most of the Riviera torrents. For instance, the channels of the streams near Menton, Vintimiglia, and elsewhere, are far out of all proportion to the work they have to do. Take the case of the principal stream at Menton. At a distance of less than two miles from the sea where its bed is formed of rock, it has only a breadth of a few yards, and has no high flood-marks indicating that there is ever a great depth of water. If the stream is followed downwards from this point for less than a mile, the bed is found to open out to a breadth of from sixty to seventy yards. Between these points there are no tributary streams adding their waters to account for this increase. These large river-beds are caused by the nature of the country which these rivers drain. The country is very mountainous, the hill slopes are rocky and steep, large areas have no covering of soil, and what soil there is does not retain the water well. The result of this is, that when rain falls the water rapidly finds its way to the streams, and the same amount of rainfall is discharged by these streams in a few hours as is discharged in weeks by an English river draining the same area. This accounts for these torrents rising so "high" and falling so "low." It also accounts for them "rising" and "falling" rapidly.

But further, the great and unnecessary breadth of these torrent-beds where they approach the sea seems to be produced somewhat in the following way:—The valleys through which these streams flow descend rapidly from the mountains, but as they approach the sea their slope becomes much slower; the result of this is, that the gravel brought down by the river from its higher and more rapid reaches, is here deposited, on account of the water losing its velocity, and the bottom of the valley becomes filled with a bed of gravel, through which the stream winds sometimes in one part, sometimes in another. A very small cause being sufficient to make the stream "cut" into the gravel and alter the position of its bed, and cause it to flow in different parts of the channel at different times, but it almost never covers at one time the whole breadth of it.

That the bed of the principal stream at Menton is unnecessarily large, is evident from the fact that now, on account of the increased value of land, they are building a retaining-wall near the centre of the stream, and filling up about one-half of the river-bed for the purpose of cultivation.

Rivers similar to those of the Riviera are common to all mountainous countries, Britain not excepted. There is at least one salmon river in Scotland, which during the dry season may be walked across without wetting the soles of one's boots, all the water finding a passage among the gravel. Yet in Autumn, when it has fallen to "fishing condition," it is a stream of about thirty yards broad, and an average depth of about two feet on the fords. This river is also subject to great floods, which "come down" rapidly, and "fall" rapidly. It also has gravel deposits similar to those of the Riviera torrents, but in this case they are covered with soil and cultivated, and it is with the greatest difficulty and at great expense that the river is prevented from widening its channel to the proportions of those of the Riviera torrents. JOHN AITKEN

Bellagio, Lago di Como, Italy

Method of Distributing Astronomical Predictions

I BEG leave to observe that the very useful method of distributing astronomical predictions over a given geographical area alluded to in NATURE, vol. xiii., page 71, and ascribed there to Mr. W. S. B. Woolhouse, was already proposed by my father, J. J. von Littrow, in his treatise, "Darstellung der Sonnenfinsterniss vom 7 September; 1820," Pest, 1820, as well as in the *Berliner Astronomisches Jahrbuch*, for 1821, page 116, and 1822, page 145; subsequently in his "Theoretische und practische Astronomie," Wien, 1821, part ii., page 280; and last in his "Vorlesungen über Astronomie," Wien, 1830, part i., page 306. Since then numerous applications have been made thereof. My father expressed the well-founded desire that in the astronomical almanacs formulæ might be given similar to that communicated in NATURE. CHARLES DE LITTROW

Vienna, June 1

Acoustical Phenomena

IN connection with Doppler's disputed theory of the colours of stars, the illustration usually employed to assist the mind in forming a conception of the hypothesis is that of the whistle of a passing locomotive. The note of the whistle, which, as it approaches, seems shriller than its normal pitch, owing to the greater number of vibrations impinging upon the ear in the unit of time, falls half a tone more or less, as the engine passes and recedes. To unmusical ears the difference in the note is a very doubtful fact, only to be taken on hearsay. There is, however, another fact of kindred nature to which attention has not, I believe, been generally drawn. Almost all railway engines, and especially those drawing heavy goods' trains, have, owing to the manner in which the valve-gearing is set, the property of producing the well-known *staccato* puffs of steam, audible to the ear as well as evident to the eye. Anyone who will listen to these puffs as the train dashes by will be aware of a very distinct and well-marked change in their apparent rapidity of succession at the moment of passing. So distinct is the change that almost invariably the first effect on the mind is the illusory suggestion that the train has suddenly slackened speed. This change is heard best at night, and when the passing train is a heavy one, not running too quickly. It cannot fail to be appreciated even by non-musical ears. As an illustration of a scientific principle it is, perhaps of the greater value, as a popular error seems to exist on the subject of the change of the note of the whistle, to the effect that the lowering in pitch is very gradual during the approach and recession of the engine, an opinion obviously incorrect if the observer be close to the train.

London, June 7 S. P. THOMPSON

Giant Tortoises

IN NATURE, vol. xiv. p. 60, it is stated that Commander Cookson, of H.M.S. *Petrel*, is bringing home two live specimens of the giant tortoise of the Galapagos; that *if* their food lasts, and *if* they are not killed by the cold off Cape Horn, they will be the first specimens seen alive in this country.

Even should the tortoises survive the two *ifs* above given, they will not be the first living specimens seen in this country.

A large specimen brought from the Galapagos Islands by one of the ships of the late S. R. Graves, M.P., lived in good health for nearly ten years in our Dublin Zoological Gardens.

This animal was examined, after death, by Dr. Gunther, who states that it is not identical with the Indian species, as supposed by former naturalists. SAMUEL HAUGHTON,
Secretary Royal Zoological Gardens, Dublin

Trinity College, Dublin, June 2

Photography of the Loan Collection Apparatus

THE Loan Collection of Scientific Apparatus at South Kensington contains many apparatus, as for instance the first air-pump of Otto von Guericke, the first boiler of Papin, the first locomotive, &c., which for the friends of science will ever be of great historical interest. Therefore I cannot refrain from expressing the wish that opportunity should be given to take photographs of convenient size of some of the most interesting apparatus. I believe many visitors will feel with me greatly gratified if such a more enduring remembrance could be taken home of an exhibition that perhaps for ever will remain unequalled.

The Hague, June 12 L. B.

ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE

THE courteous request of the editor of NATURE that I should contribute to his pages an abstract of my experience of the value of experimentation on animals and on the most useful applications of that method of research to the alleviation, directly or indirectly, of animal suffering in all the higher classes of animals is responded to in the subjoined notes.

I have already expressed my views on this subject on two occasions at large public meetings of the Royal Society for the Prevention of Cruelty to Animals, and in 1862 I made a report on the same subject to the indefatigable secretary of that society, Mr. Colam, which report he has recently published, and which on the points it refers to is in harmony with the conclusions of the late Royal Commission. I have not, however, entered into the discussion that for some months past has been in

progress, and this for the simple reason that in the violence, I had almost said distemper, of the controversy, I felt I could take no part. In what I am now about to record I shall merely bear witness of what I know without prejudice to either side. I state this at once because I feel morally sure that if I had not been a physician, and if I had not from that circumstance studied the question in connection with human suffering in its most poignant aspects, I should have been one of the strongest partizans amongst those who are most strongly opposed to experimentation. I differ indeed only from them in that I have been obliged to consider the pains of men, women, and children in my daily labours, and have been forced to the conviction that the actual suffering of the inferior animals bears no comparison with that which is borne by the human family; that the mental sufferings alone of man exceed the physical pains of the lower creatures; and that his physical pain is greater in amount, in intensity, and in appreciation.

For my part, the experience I have gained from experimentation has, from the beginning to the end, through a long period of twenty-six years—during which it has at intervals been sought—sprung in almost every instance, directly from the desire to apply scientific research to the instant use of the practising physician. With rare exceptions every inquiry has been prompted by some painful difficulty that has been suggested at the bedside of the sick, or by the sight of operation on the human subject.

If, therefore, experiment on animals can be vindicated by its application to practice, my experience may be of use in settling doubts in the minds, at least, of those who are not unduly biassed on either side.

Experimentation on Death from Chloroform

The first series of experiments I remember to have made were commenced in the years 1850 and 51, and had reference to the mode and cause of death under chloroform. At the time named chloroform had been in use a little over two years, for preventing the pain of surgical operations, and already nineteen deaths in man had occurred from it.

These calamities had produced very painful and anxious feelings amongst medical men, and my researches had for their intention the elucidation of many points of practical importance. The mode of procedure was to narcotise the animals with varying degrees of rapidity, with varying percentages of chloroform vapour in the atmosphere, and during various atmospherical conditions: to note carefully the phenomena produced on the heart and on the respiration, and the duration of the four stages of narcotism. In some instances the animals rabbits were usually subjected to experiment—were allowed to recover; in other instances the narcotism was continued to death. When the narcotism was made to be fatal the immediate cause of death was noted, and the body was left until the rigidity of death could be recorded. Then all the organs were carefully inspected in order to see what was the condition of the lungs, the heart, the brain, the spinal cord.

The results obtained by these inquiries were of direct practical value. By them I showed in various lectures and papers the following major facts:—

1. That the cause of the fatality from chloroform does not occur, as was at first supposed, from any particular mode of administration of the narcotic.

2. That chloroform will kill, in some instances, when the subject killed by it exhibits, previous to administration, no trace of disease or other sign by which the danger of death can be foretold.

3. That the condition of the air at the time of administration materially influences the action of the narcotic vapour. That the danger of administration is much less when the air is free of water vapour and the temperature is above 60° but below 70° Fahr.

4. That there are four distinct modes of death from chloroform, and that when the phenomena of death from its application appear, they are infinitely more likely to pass into irrevocable death than from some other narcotics that may be used in lieu of chloroform.

5. That all the members of the group of narcotic vapours of the chlorine series, of which chloroform is the most prominent as a narcotic, are dangerous narcotics, and that chloroform ought to be replaced by some other agent equally practical in use, and less fatal.

6. That so long as it continues to be used there will always be a certain distinct mortality arising from chloroform, and that no human skill in applying it can divest it of its dangers.

That knowledge of this kind respecting an agent which destroys one person out of every two thousand five hundred who inhale it was calculated to be useful no reasonable mind, I think, can doubt. To me who, many hundred times in my life have had the solemn responsibility of administering chloroform to my fellow-men, it was of so much value that I should have felt it a crime if I had gone blindly on using so potent an instrument without obtaining such knowledge.

Experimentation with reference to the Deposition of Fibrine in the Heart, and Prevention of Death from that Cause.

From 1851 to 1854 I was closely occupied in the study of that mode of death which is caused by the separation of the fibrine of the blood in the cavities of the heart. At the time named a medical controversy which had been all but silent for a hundred and fifty years, on the question whether the separations of fibrine which are often found in the heart after death are formed before death and are a cause of death, or are formed after death and are a mere consequence, was revived and was carried on, with much activity, by physicians of different schools. I took a leading part in supporting the view that the separations of fibrine took place, as a rule, before death, and were the cause of death. I did a great deal to prove the truth of this then controverted, and now universally admitted, position, and I gave the first detailed description of the symptoms which indicate the formation of the clots in the cavities of the heart. The result was that I soon became too sadly familiar with this class of case, for I found that the symptoms, whenever they were fairly pronounced, indicated the certain death of the sufferer. These observations led me, naturally, to look for a remedy; to an endeavour to find a means by which the clot of fibrine in the heart could be made to undergo solution. Taking clots that had been removed from the dead and had been causes of death, I subjected them to different solutions to determine their solubility. I found them soluble in some alkaline solutions, and amongst other solutions in ammonia. I also observed that ammonia added to blood held the fibrine of the blood, from which these clots are formed, in solution. The fact led me to expect that by the use of such alkaline solutions a true solvent remedy might be found. A case occurred in which symptoms of fatal character were fully developed, and in the hope of producing solution of the coagulum in the heart, full doses of bicarbonate of ammonia were repeatedly administered. To my great satisfaction the signs of oppression at the heart ceased, life was evidently prolonged, and a fair chance of recovery was presented. The hope of recovery was in a few hours, however, destroyed; coma supervened, and the patient died from that added cause of death. The *post-mortem* revealed that the blood throughout the body was fluid, and that the clot which had been in the heart had undergone all but complete solution. But the red corpuscles of the blood were found also to have undergone the extremest disintegration, and the brain and other vital organs were intensely congested.

The inference I drew at this time, it was in 1854, from

the example in question, was that the remedy which had caused solution of the coagulum had saved life by that process to destroy life by the extension of the solvent action to the blood corpuscles, and this opinion was so fully confirmed by experimentation, that I gave up further inquiry on the subject, from the feeling that its continuance was not warranted. A period of seventeen years now elapsed, in every year of which I had occasion to see from five to six instances of death from this one cause. Some of the deaths from the cause named occurred after surgical operations, such as ovariotomy, some from croup and other inflammatory affections, others before or after childbirth. In 1870 I computed that I had witnessed ninety-seven of these fatal catastrophes. Meantime there had been found no remedy, but I had learned from the added experience one new fact, viz., that in three instances, although no ammonia or other solvent of the blood had been employed in treatment, the symptoms of coma supervened precisely as in the case where ammonia had been administered. At last I obtained one clear evidence that the reason of the symptoms was a separation of fibrine in the sinuses of the brain.

Recurring once more to the use of ammonia as a solvent of the deposited fibrine, I thought it justifiable now to renew experiment. It might, I felt, be the best course to administer the simple liquid ammonia instead of a salt of that substance, by which means I hoped the solvent action would be obtained by an agent that was more easily eliminated from the body when the administration of it was withdrawn.

To what extent I might administer the solvent, how far I might venture to produce disintegration of the corpuscles of the blood and hope for recovery, was the point to be arrived at. It could only be arrived at by one of two methods—by trying the experiment on the inferior animals, or by waiting for the opportunity of testing the remedy directly on man in some extreme case of the diseased condition specified. I chose, and I think correctly, the first of these alternatives. I subjected an animal, a guinea pig, to the administration of ammonia diluted as it might be for the human subject, and I continued the administration until I found, firstly, that life was possible and safe under a degree of solution of blood which in the absence of such a direct test would have been thought impossible; and secondly, that on the withdrawal of the solvent agent the natural state was slowly but completely restored. I repeated the research in order to test the best mode of administration. I tried on myself the doses that could be swallowed without actual pain, and then I planned the measure I would adopt when another instance of obstruction of the blood in the heart came under my care. I need not repeat here, in any detail, the satisfactory results of this inquiry. The facts have been recorded at length before the Medical Society of London, have been made widely known in the profession of medicine, and have gathered confirmation from others. It is sufficient for me to state that in 1872, in an example of this fibrinous obstruction in the heart, when the sufferer was to all known observation *in extremis*, the treatment by ammonia, in doses which would have been considered poisonous had not experiment on animals proved the contrary, was pushed to the full; that the evidence of solution of the obstructing mass in the heart was perfect; and that complete recovery, I have no doubt the first recovery of the kind, was the result. Since then I know of eight more examples in which the same rational method of treatment has been applied, with the result of six recoveries.

Experimentation for Surgical Learning.—Ovariotomy.

I have sometimes had occasion to perform, or take part in experiments on the lower animals in order to learn some important detail of *surgical* practice. The following experience of this nature is worthy of special note.

When Mr. Spencer Wells was beginning his career in performing the operation of this century, —the removal of ovarian tumours,—a difficulty arose on the point whether in closing up the wound in the abdomen the peritoneum ought or ought not to be included in the stitches. At the present time, when so much is known, this subject may appear of little moment; then it was of vital moment. The peritoneum had been held by all authorities to be of such importance in the animal economy that to cut or injure it was thought to be actually a deadly act, and a man who intentionally injured the peritoneum, in operation, was considered, by many, as little better than a wanton and wicked experimenter on human life. Ought any one, therefore, to venture to put two rows of stitches through this structure? Mr. Wells wished to ask the question of nature, by experiment, and I helped him. Eighteen animals of three classes—guinea-pigs, rabbits, and dogs—were first thoroughly narcotised. Then the same incision was made into the abdominal cavity as is made in ovariotomy. Afterwards the incision was neatly and closely sewn up, in one set of experiments with the peritoneum included in the stitches, in the other set with the peritoneum excluded. The animals, on coming out of their sleep, were attended to and treated with as much care as if they had been human until their recovery, which in each case was rapid and easy. When they had entirely recovered and the wound healed, they were submitted to painless death, under anæsthesia, and their bodies were examined to determine the results of the different modes of operation.

These were the steps of the proceeding. The lessons taught were of vital value. The experimentation proved beyond dispute that the introduction of the stitches through the peritoneum added no danger to the operation. They proved further that when the peritoneum was included in the stitches, the wound healed much more firmly and safely, *a fact which could only have been learned from an operation on a subject that could be killed after operation.* From that time of probationary learning on to this time of matured experience, Mr. Wells has performed the great operation, with which his name is for ever identified, 770 times. In every instance the patients who have come under his care for operation would, presumably from past experience, have died from the disease. Of his patients operated on an average of three out of four have recovered. He has, therefore, by his own hand saved between five or six hundred women from one form of certain and lingering death. Towards this result—a result grander than has ever before fallen to the lot of any operator of any age he was fortified by the experiments I have described to an extent which no one but an operator himself can fully appreciate.

I am aware there are some who would urge that he might have learned the facts he wanted to obtain by experience, that is to say he might have waited for the results from his operations on women. This plan would have made several women in the prime of life subjects of experimental inquiry. I am aware that some would say it were better the operation had been dropped than that any animal whatever had been subjected to suffering for its sake. This plan would have been an obstacle to the saving of over five hundred women from early and certain death in the practice of Mr. Wells alone. But when it is remembered that his teaching and example have been followed wherever surgery is practised, the numbers of women saved from death and suffering during the last fifteen years in consequence of what was learnt by sacrificing some eighteen dogs, rabbits, and guinea-pigs, it is obvious that those who estimate human life at its real value and observe human suffering in its most distressing forms are compelled, however painful to their own feelings, to think and act first for the best interests of the human family.

What Lord Selborne, one of our most distinguished

Chancellors, thinks of the results of Mr. Wells's work may be gathered from one of his published speeches. He calls it "one of the most splendid triumphs of modern surgical art and modern philanthropy, one of the greatest achievements of medicine or surgery in any age." Mr. Wells himself has repeatedly urged that what he learnt by the result of the experiments we performed together has been of the utmost importance for the success of the operation, and in a note addressed to me to-day he repeats and permits me to publish his views in his own words :—

"The few experiments we made on the narcotised animals taught in a few weeks, in the early days of ovariotomy, what I could not have learned to this hour, after many years' observations on suffering women. To my mind, the loss to the world by the few animals sacrificed, when compared with the gain by the lives of the thousands of suffering women already saved, wherever the improved methods of operating learned by these experiments has been followed, is so utterly disproportionate as not even to be worthy of consideration."

BENJAMIN W. RICHARDSON

(*To be continued*)

OUR ASTRONOMICAL COLUMN

THE COMET OF 1698.—The orbit of the comet of 1698, which appears in our catalogues was calculated by Halley from the observations of Lahire and Cassini at Paris. In his "Synopsis of the Astronomy of Comets" he remarks that the comet "was seen only by the Parisian observers who determined its course in a very uncommon manner. This comet was a very obscure one, and although it moved swiftly, and came near enough to our earth, yet we, who are not wont to be incurious in these matters, saw nothing of it."

The comet was detected on Sept. 2, between β and κ Cassiopeæ, and thence pursued a southerly course until on the 28th of the same month it was last observed between ξ and ψ Scorpii. On calculating geocentric places from Halley's orbit, it appears that the elements as originally published by him, and as they have been successively copied into all our catalogues, give an apparent track in the heavens which is totally different from that recorded by Lahire and Cassini, and described in *Anciens Mémoires de l'Academie des Sciences*, t. x., and which is traced on the chart in the *Mémoires* for 1702. Employing positions deduced as closely as practicable from the somewhat imperfect details in our possession, for Sept. 2, 15, and 28, the following orbit results :—

Perihelion Passage 1698, Sept. 17·0214 Paris mean time.		
Longitude of the perihelion ...	274° 42′	Equinox
,, Ascending node ...	65 53	of 1699.
Inclination	10 55	
Log. Perihelion Distance ...	9·86252	
Heliocentric motion — retrograde.		

On comparing these elements (which very fairly represent the apparent track of the comet) with Halley's, it is at once evident that the cause of the failure of the latter is the substitution in the "Synopsis" of the longitude of the *descending*, instead of that of the *ascending* node, an oversight which appears to have escaped detection hitherto. Making this change in Halley's elements they will stand as follows :—

Perihelion Passage 1698 Oct. 18 at 16h. 57m. Greenwich		
Longitude of Perihelion ...	270° 51′ 15″	time.
,, Ascending Node	87 44 15	
Inclination	11 46 0	
Log. perihelion distance ...	9·83966	
Motion — retrograde.		

The first orbit appears to agree better upon the whole with the path of the comet laid down in the above mentioned diagram.

THE BINARY STAR ω LEONIS.—In the "Transactions of the Royal Irish Academy," vol. 26, Dr. Doberck has given the details of a very elaborate determination of the orbit of this star, on measures extending to the spring of the present year. Madler had previously given two orbits, Villarceau one, and Klinkerfues three, so that the object had not been neglected, but a longer course of measures than had been employed by these calculators was required for a trustworthy approximation to the orbit. Dr. Doberck presents the following elements as definitive for the present :—

Peri-astron passage	1841·81
Node	148° 46′
Angle between the lines of nodes and apsides (λ)	121° 4′
Inclination	64° 5′
Excentricity	0·5360
Semi-axis Major	0″·890
Period of revolution	110·82 years.

From these elements we deduce the following angles and distances, exhibiting the course of the companion during the present century :—

1878·0	Pos. 75°·1	Dist. 0″·56	1890·0	Pos. 102°·4	Dist. 0″·75
82·0	,, 86·0	,, 0·62	94·0	,, 108·5	,, 0·82
86·0	,, 95·0	,, 0·68	98·0	,, 113·6	,, 0·89

Some remarks on the correction of orbits of double stars, appended by Dr. Doberck to his paper on ω Leonis, one of the most complete of the series emanating from Col. Cooper's Observatory at Markree Castle, may be useful to those who are occupied with these orbits.

VARIABLE STARS.—(1) Olbers' supposed variable, near 53 Virginis. Mr. J. E. Gore, writing from Umballa, Punjab, on May 13, says he examined the place of this star a few nights previous with a 3-inch refractor, and found it about 9 m., being about equal in brightness to Olbers' star *c*, and brighter than his star *d*, which latter appeared more nearly 9½ or 10 than 11, as given by Olbers. With an opera-glass the suspected variable was "about the faintest star in the immediate vicinity of 53 Virginis."

(2) 5 Ceti.—Recent observations afford a suspicion of variability to a small extent in this decidedly reddish star, which, by the way, is not found in Schjellerup's second catalogue of objects of this class. It may be advantageously compared with its neighbours 4 Ceti and B.A.C. 5. (3) The Companion of Algol. The small star near β Persei, appears to have been first remarked by Schroter, on October 12, 1787, with a 7-feet telescope, power 160; on November 3 the distance was estimated 1′ 30″. On April 9, 1788, he could not find the small star, and hence concluded it to be variable. Observations during the last two or three years have rather indicated fluctuation of brightness, the star being sometimes caught at once, and at others only perceived with difficulty, employing the same telescopes and on nights not differing materially in transparency. It would not be without interest to ascertain definitely by systematic observation whether there is any ground for the suspicion first entertained by Schröter.

THE DOUBLE-STAR γ CENTAURI.—Will one of our southern readers put upon record the actual angle of position and distance of this object, to decide upon the direction and amount of the motion, which at present are by no means obvious? Capt. Jacobs' measures in December, 1857, showed that the star was widening, as compared with his estimate in March of the preceding year, but he found a retrograde change of angle to the amount of 7°, whereas the angle of 1856, compared with Sir John Herschel's measures in 1835-36, rather poitn to direct motion. Capt. Jacobs says, in 1857, "Has opened sensibly since 1853, being now an easy object, whereas then, under the most favourable circumstances, it could only just be discerned as not round."

THE MAMMALS AND BIRDS OF BURMA[1]

DURING the last few years of his life, the late Mr. Edward Blyth—whose death on December 27th 1874 we referred to on the following week—devoted much of his time to the production of a Catalogue of the Mammals and Birds of Burma. This he had originally commenced as a sketch of the Natural History of Burma, to form a chapter in a work on that country by Sir A. Phayre; but as he had gone too exhaustively into the subject for that purpose, Sir Arthur, on receiving the manuscript after its author's death, handed it over to Mr. Arthur Grote, with the view of its being published in the "Journal of the Asiatic Society of Bengal." To this the Council of the Society willingly assented, the result being that Blyth's posthumous "Catalogue of the Mammals and Birds of Burma" has appeared as an extra number of that journal, with an interesting and detailed biography by Mr. Grote. Different authors, with notes and additions, edit the different sections. Dr. John Anderson, the present curator of the Indian Museum of Calcutta, has undertaken the Mammals, with the exception of the Bats, which have been placed under the charge of Dr. G. E. Dobson; whilst Lord Walden edits the Birds. The editorial notes are all inclosed within brackets, so that there is no difficulty in distinguishing the author's own views. Without the notes and additions the work would not have been a complete one; as it now appears, it is an exhaustive account of the mammali- and avi-fauna of the Burmese portion of our Indian Empire.

Mr. Blyth's peculiar power of perceiving specific differences, together with his general scientific acumen, had full opportunity of displaying themselves when he in 1841 undertook the charge of the mass of unassorted material, in the forms of skins and bones, accumulated at Calcutta by the labours of Messrs. Hodgson, Cantor, and others. His thorough study of these enabled him to employ to the greatest advantage the opportunities which occurred to him of visiting Burma, which he did on several occasions, between 1860 and 1862. The results of these are embodied in the work under consideration, which as a simple catalogue would have been valuable, but is made doubly so by the extremely instructive comments which accompany many of the descriptions, and indicate how acute were the powers of their author as a naturalist. This may be further proved by the fact that of the 129 species of mammals known to inhabit Burma, thirty are recognised by names given by him.

As a point to which we would take exception we must refer to the name by which the author designates the "Ear-fringed Rhinoceros," first described by Mr. Sclater, from a unique specimen now living in the Zoological Gardens in the Regent's Park, as *Rhinoceros lasiotis*. It happened that Dr. Gray had given the name *R. crossii* to the owner of a rhinoceros horn, 17 inches in length, the shape of which was different from that of any known species. Why, when a new species is discovered, the horn should be assumed to be one of those belonging to it, is far from easy to understand, and Mr. Blyth gives no reasons for his nomenclature. He does place a note of interrogation after the name. If we remember correctly, the stuffed specimens of *R. sumatrensis* in the British Museum bear the name of *Ceratorhinus crossii*.

METEOROLOGY AT MELBOURNE[2]

THESE first three volumes of the new issue of the results of the meteorological observations carried on in Victoria under Mr. Ellery's direction, give copious details of all the work done at Melbourne, the chief observatory of the colony, the means and extremes of barometer and thermometer at from six to ten stations, and the amount and days of the rainfall at from twenty-six to thirty-four stations, the latter being the number of rainfall stations in 1874. To these are added, copious and very valuable *résumés* from all the thirty-four stations, of electrical phenomena, hail, frost, snow and sleet, fog, hot winds, storms of wind, auroras and earthquakes, most of which form so important elements in the climatology of Victoria.

The daily results for pressure, temperature, and evaporation, which are printed for Melbourne from observations made at 6 and 9 A.M., and 3 and 9 P.M., have been "corrected" so as to render their values, and those derived from them, equivalent to those deduced from hourly observations, presumably from the hourly values determined by Dr. G. Neumayer. This method of publishing results is objectionable particularly as regards daily observations; and even as regards monthly means, it is not free from serious objection, because, owing to the varying limits of the daily oscillations, this method of correcting observations must frequently mislead.

The anemometrical results for Melbourne are extremely valuable. In the summer months southerly winds and in the winter months northerly winds largely preponderate. Thus in 1874—while in January northerly winds (N.E., N., N.W.) showed a percentage of 11·3, southerly winds (S.E., S., S.W.) showed a percentage of 74·0; in July, on the other hand, the numbers were, northerly, 58·9, and southerly, 23·2. Again, in July, the three hours of the day showing the least velocity of the wind are 4 to 7 A.M., the mean being 7·2 miles per hour, and the three hours of greatest velocity noon to 3 P.M., the mean being 11·8 miles. But in January the three hours of least velocity are 3 to 6 A.M., the mean being 6·3 miles, and the three hours of greatest velocity 2 to 5 P.M., the mean being 15·8 miles. Hence in summer, even though storms of wind are then least frequent, the maximum daily velocity of the wind which occurs two hours later, is 4 miles greater an hour, being the direct result of the powerful action of the sun on the heated plains of the interior of Australia. It is to be hoped that in future issues Mr. Ellery will be able to add to these invaluable tables, a table showing the mean hourly variation in the direction of the wind for each month, a climatological datum of the first importance in Meteorology to which we have recently drawn attention in reviewing the reports of Toronto and Habana.

To each month's results are added the barometric, thermometric, hygrometric, and rain averages for eight of the stations, and since nearly all these averages are for periods varying from eleven to sixteen years, some interesting conclusions of a general character may now be drawn applicable to the whole colony. Thus in January the average pressure at 32° and sea-level is 29·962 inches at Cape Otway, on the coast, and 29·893 inches at Sandhurst, in the interior; but in July the averages are respectively 30·042 and 30·110 inches. These results show a diminution of pressure during summer in advancing inland, and an increase in winter, a distribution of atmospheric pressure in accordance with the prevailing winds in these seasons. In January the mean temperature varies from 60°·6 at Cape Otway to 70°·8 at Sandhurst; and at Beechworth, which is still more decidedly inland, the mean temperature is 2°·0 above that of Sandhurst, though it be fully 1,000 feet higher. At Cape Otway the difference between the coldest and warmest months is 13°·4, whereas at Sandhurst it is 25°·1.

The mean annual temperatures of Cape Otway 54°·7, and Portland 61°·5, call for examination. Cape Otway and Portland, which are nearly in the same latitude, both on the coast and only about fifty miles apart, show thus a difference in their mean temperatures of 6°·8, or a differ-

[1] "Catalogue of Mammals and Birds of Burma." By the late E. Blyth, C.M.Z.S. "Journal of the Asiatic Society of Bengal," new series, vol. xliii. Part 2.

[2] Results of Observations in Meteorology, Terrestrial Magnetism, &c., taken at the Melbourne Observatory during the years 1872, '73, '74, with Abstracts from Meteorological Observations obtained at various Localities in Victoria, under the superintendence of Robert L. J. Ellery, Government Astronomer.

ence equal to that between Greenwich and Montpellier in the south of France—a difference which might possibly arise from extraordinary and diverse ocean-currents—but to such a supposition current charts give no support. The publication might be rendered even still more useful by including among the means those of the maxima and minima of temperature, and those at the hours of 9 A.M. and 3 P.M. for pressure and temperature at all the stations, and by indicating on the map the whole of the stations from which observations are given in each year's publication.

AMERICAN-INDIAN STONE TUBES AND TOBACCO-PIPES

DURING the summer of 1873, I found a single specimen of a stone tube, that had been split throughout its entire length, as seen in Fig. 1. Since then, I have had an opportunity of examining several specimens found in New Jersey, and fortunately found two in the locality of my principal labours, in gathering up the scattered relics of the aborigines.

Fig. 1 is made of beautiful veined green and black slate, is six and one-eighth inches in length, slightly oval, and has been highly polished. The bore, which is exactly half-an-inch in diameter, is circular, uniform and direct. The drilling has evidently been accomplished by the use of a reed with sand and water, and the circular striae are visible throughout the length of the perforation. This drilling is the more interesting from the fact, that the work, commenced at one end, has been continued to the other, and not from either end to the middle, which latter method (and much the more common one) produces an hour-glass contraction at the point of juncture of the two drillings. Six or seven inches, however, was not the maximum depth attempted at drilling in one direction. Prof. Wyman, in "Fifth Report of the Peabody Museum of Archæology,"

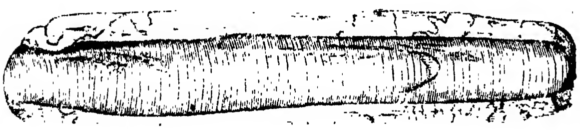


FIG. 1.—One-half natural size.

p. 13, describes "a cylindrical tube of soap-stone, twenty-two inches long and two inches in diameter, tapering somewhat at either end. This had been drilled from opposite ends, but the two perforations not coinciding, they passed by each other, the bores communicating laterally." We have in this implement, therefore, a single bore at least twelve inches long; which is probably the maximum length, for it is difficult to conceive of a stone to be of greater length than two feet, being of any use.[1] This is about the maximum of the non-perforated cylindrical stones called pestles; but which probably had other uses than that name implies.

Fig. 2, represents a quite common form of ornamental stone implement, but which, unfortunately, are seldom found except in very fragmentary condition. This specimen measures six and seven-eighths inches in length, by eight inches, lacking three-sixteenths, in breadth. The mineral is a soft sandstone, smoothed but not polished, and free from all attempt at ornamentation. Such specimens, when of less dimensions, have ordinarily been classed as badges of authority, gorgets, or if narrower, as double-edged axes, which could never have been their use, considering the soft material of which they are invariably made. As the perforation of this specimen exceeds in length that of the preceding, I am led to consider this simply as a "winged" tube, and to have had a use identical with such as above described (Fig. 1). While cylindrical tubes, plain or onamented, are quite abundant in

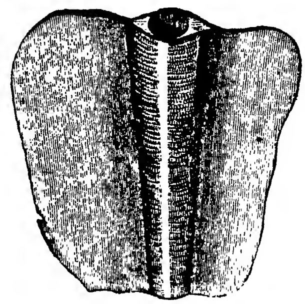


FIG. 2.—One-fifth natural size.

the southern and western states, these winged tubes appear to replace them in the northern and middle states.

Figs. 3 and 4 represent two specimens of tubes, that are of much interest, in that, while of the same general character as the preceding, they have not been bored; but are made of clay which has been moulded when soft, about a straight cylinder, presumably of wood, and then baked very hard. The exposure to fire would necessarily char, if not consume, the encased wood, and so leave a perforation in the clay when baked. This tube has then been brought to its present shape by scraping, and the ornamentation lastly carved upon it. In both specimens, the projective figure has been broken off, but the remaining fragment in Fig. 3 suggests the figure of a mammal, and that of Fig. 4 possibly a human head. On the tube, Fig. 3, will be noticed five short parallel lines. Such rows

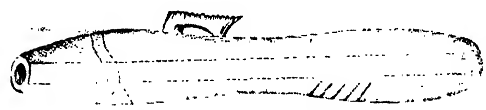


FIG. 3.—One-third natural size.

of short deeply engraved lines are very characteristic of the relics found in New Jersey (see figure of Marriage Emblem in NATURE, vol. xi., p. 436), and are probably record marks, but of what, on an implement like this, it is difficult to conjecture. The general shape of these tubes, and their diameters render it quite certain that they are not simply the stems of clay smoking-pipes.

These two specimens were found in the same grave, associated with the ordinary weapons of the aborigines; axes, spears, and arrow-points.

Fig. 5 represents a stone tube of a pattern quite different from any of the preceding. It is made of very soft soap-stone, is quite smooth, and accurately outlined. It is four and three-fourths inches in length; one and one-fourth inches in width at the broad, trumpet-mouthed end, and half-an-inch in diameter, where broken. The

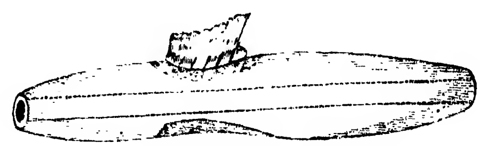


FIG. 4.—One-third natural size.

perforation is one-fourth of an inch in diameter, and of uniform size throughout. Such trumpet-shaped specimens occur elsewhere. Prof. Jeffries Wyman describes one in the Report above quoted, same page. He writes: "A fragment of another tubular instrument of the same ma-

[1] Mr. Evans, in his "Ancient Stone Implements of Great Britain," remarks that "the tubes of steatite one foot in length, found in some of the minor mounds of the Ohio Valley, must probably have been bored with metal." This depends altogether upon their age. New Jersey specimens of tubes have been found of nearly that length, which undoubtedly were made before the introduction of metal.

terial (soap-stone) appears to have had a long cylindrical body, and ends in an enlarged and trumpet-shaped mouth, and possibly was used as a horn."

Fig. 5 has faintly engraved upon it a serpent, or what appears to have been one. This representation of a serpent, and the figures on the specimens, Nos. 3 and 4, have probably the same object. Either they represent the owner, the name of the object being that of the possessor of the tube; or, if they were used solely by the sorcerers as "medicine tubes,"[1] wherewith they blew away disease, then the serpent in the one case, and the figures, now undeterminable, on Figs. 3 and 4, were the "gods" or "devils," through whose inspiration the "doctors" effected their cures. How to explain the meaning of the "wings," of Fig. 2, is certainly difficult, if I am correct in my surmises concerning the other specimens; but these may simply be meaningless ornamentation, just as the broken specimen, Fig. 1, when entire, was just as effectual as any in blowing away disease, provided the suffering patient was made to believe so, by entertaining faith in his physician.

A few words in conclusion upon the use of stone drills in boring through stone. There is, in the museum of the Peabody Academy at Salem, Massachusetts, several hundred specimens of stone-drills, all of jasper, and varying greatly in length. These specimens, collected by the writer, have been frequently experimented with, and they are found capable of very rapidly drilling in the minerals of which these tubes and "gorgets" usually are made. And when sand and water are used in addition, it is not extremely difficult to drill in mineral of like or greater density. Stone-drills, such as here referred to, are not flat, like a slender arrow-point, but quadrangular (diamond-shaped) when viewed in section. The points of the few

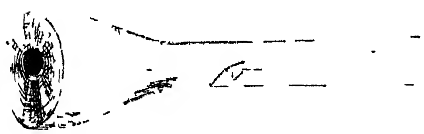


Fig. 5.—One-half natural size.

perfect specimens I have found, were mostly very highly polished, and the sides showed clearly, in some specimens, the action of sand. These drills vary from one to seven inches in length, and from three-sixteenths to over an inch in diameter; or rather the bores they made, had these measurements. Figures of such drills are given in vol. vi. of "American Naturalist," pp. 205—214; also by Mr. Evans, in "Ancient Stone Implements of Great Britain," p. 290, Fig. 230. None of the drills, however, mentioned by Mr. Evans, are large, and are capable only of perforating thin plates of stone. While convinced that a reed, with sand and water was most frequently used in deep bores, I can see no reason for doubting that stone-drills were also used; for such specimens are by no means rare, and no other use can be suggested for them.

The various forms of stone implements found in New Jersey, however specialised, appear to be all traceable to others, far less elaborate, and these ruder patterns, as I have endeavoured to show, are now found at such depths, as a mile, that they may safely be considered as of greater antiquity and the forerunners of the more finished types, the true surface-found specimens. From this fact I have concluded that the red man of the Atlantic coast of North America reached our shores a palæolithic savage, and when discovered by the Europeans had attained to the neolithic stage of culture.

There is one form of stone implement (and only one) that offers an exception to the assumed rule that the ruder antedate the more finished specimens; that is, the smoking pipes. There are no rude or palæolithic pipes occurring in New Jersey, nor, I believe, in any portion of the country. They are all more or less polished and so wrought that they must be classed as a neolithic form of stone implement. Among the chipped unpolished implements of the river gravels I have been unable to find any specimen that could be imagined even to be connected with the custom of smoking. There is, however, abundant evidence of improvement in the flint-chipping art having been attained by the red man while an occupant of this country, readily traced in the axes, arrowpoints, and other forms of weapons and domestic implements; and such advance is not seen in the fashioning of pipes.

For the reasons already stated, I conclude that the custom of tobacco smoking was introduced or established after the red man had attained to the higher division of the Stone age; and that the first pipes were of perishable materials. Such pipes must, I think, have been of wood. Succeeding the use of this, which was necessarily inconvenient, there is reason to believe that a rude clay bowl was attached to the stem, a mere shapeless lump of clay that they would soon learn was rendered somewhat more durable by the exposure to heat. The use of clay bowls might have arisen, too, by the hardening of the earth simply, if the first receptacle for the tobacco was simply a depression in the ground, to the bottom of which was

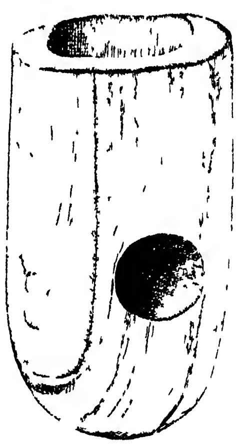


Fig. 6.—Plain Pipe Bowl, natural size.

placed one end of the reed, through which the smoke was drawn to the mouth. However this might have been, I believe I have found fragments of pipes so rude in their shape and coarse in their composition as to warrant the belief that such specimens were the forerunners of the durable stone pipes that now occur in scanty numbers among the relics of the red men of New Jersey.

Inasmuch as the use of clay for pipe bowls was not abandoned, there of course exists a vast range of excellence in the workmanship displayed in their manufacture, and many of the fragments that I have found were as artistically ornamented and made of as carefully prepared clay as others were rude and of the coarsest material. These rudest specimens are never found in graves, and seldom met with except when deeply embedded in the soil, suggesting that they were in use before the custom of burying the smoking pipes of the dead with them was established, and therefore that they antedate the more elaborately finished specimens, which are occasionally found among the deposited relics of "grave-finds;" but such an occurrence is rare in comparison with the presence of stone pipes under similar circumstances.

While the pipe bowls of stone exhibit a considerable range in the excellence of their finish, there is not sufficient variation to warrant one in considering the more rudely finished specimens as the older. They are all well

[1] Venegas (Nat and Civil Hist of California, vol. i, p. 97. London, 1759) states: "They (medicine men) applied to the suffering part of the patient's body the *chacuaco*, or a tube of a very hard black stone; and through this they sometimes sucked, and other times blew." Quoted by C. C. Jones, junr., in "Antiquities of Southern Indians," p. 363.

made and admirably adapted to their peculiar use. Ornamentation was confined, in the vast majority of cases, to the natural markings of the mineral, and not derived from any carving as is so marked a characteristic of the pipes of the mound-builders. Fig. 6 represents a perfect specimen of such plain pipe bowls as I have described. There is no line, straight, curved, or zigzag upon it. The red man who made this specimen had utility solely in view; unless the choice of mineral was considered, as giving beauty to the finished pipe. The material of the specimen figured is a pale green slaty rock, veined with black. The variation in shape of such pipe bowls is of course considerable; and supposing each individual to have made his own pipe, the shape was in each case decided by the maker's fancy solely. As in the case of arrow-points, of which a score of patterns occur, so with pipe bowls. One will scarcely find two precisely alike; yet the "family likeness" is very strongly marked.

There does occur, however, a second form of smoking pipe, but much more sparingly than the preceding, differing greatly, both in size and shape. While the two patterns occasionally approach in general outline, they do not do so sufficiently to warrant our considering the one to pass into the other form.

This variety of pipe, of which Fig 7 is an example, is well known as the calumet or "peace-pipe." The bowl

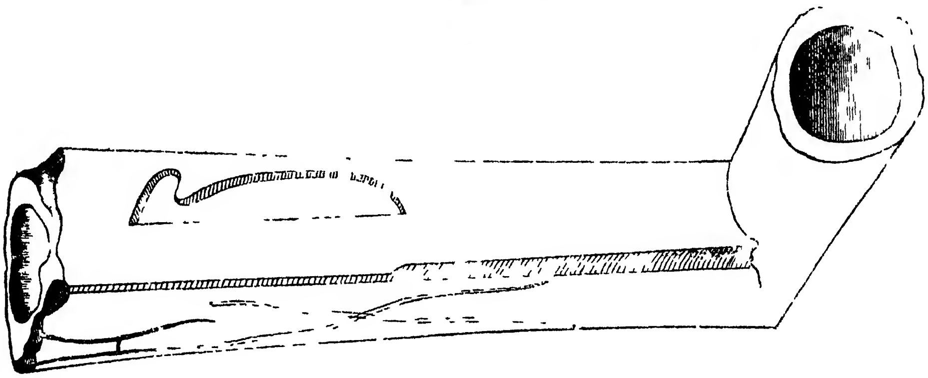


FIG. 7.- Calumet, natural size

in this case, as a rule, is much smaller, and the labour of the maker has been expended upon the stem-like base, which in every specimen I have seen has been quite elaborately ornamented. The specimen figured is not as much carved as many, but being quite perfect, is represented in preference to fragments of others.

I believe no specimens of "animal pipes," such as are found in the Mississippi valley, have been found in New Jersey, which fact is interesting, as there is much reason for believing that when the mound-builders occupied the western valleys the red man was already occupying the Atlantic coast; and doubtless some trading was carried on between the two peoples. Therefore, it would be natural to expect that such pipes should occur among our Indian relics; or at least that there was sufficient knowledge concerning them to suggest to the coast Indians the idea of imitating them; but there is no trace of such imitation I believe. It is their smoking pipes alone, of all their productions in the flint-chipping art, that are dissimilar.

Through the writings of the earlier missionaries we learn of the peculiar uses and significance of these calumets, which formed so prominent a feature on all important occasions; but whether they were introduced by some other race with whom the red man came in contact, or originated *de novo*, it is impossible to determine; but it is quite certain that the specimens so far brought to light do not enable us to trace the evolution of the calumet from the simpler form of pipe.

Trenton, N.J., U.S.A., May 6 CHAS. C. ABBOTT

NEW METEOROLOGICAL LABORATORIES AT MONTSOURIS

M. MARIÉ DAVY, Director of Montsouris Observatory, has organised, partly at the expense of the City of French Government, partly at the expense of the City of Paris, a chemical and microscopical laboratory for the analysis of all the matters in suspension in the air of Paris, both quantitatively and qualitatively. A certain quantity of air is constantly aspired by an aspirator in continued operation. The ozone acting on iodide of potassium and starch liberates iodine. The quantity of ozone liberated is measured by a titrated solution of arsenite of sodium. The matters in suspension are collected on a glass plate, and the crop is placed under the object-glass of a powerful microscope magnifying 1,000 times. The principal forms are drawn and plates are executed and published monthly in the Transactions of the establishment. The analysis of rain-water is conducted on the same principles, and the results of chemical analysis are calculated and compared with the wind and other atmospheric circumstances.

We are indebted to M. Marié Davy for the principal results of the month of February, the first period for which the whole system has been put into complete operation.

The electrical department has been fitted up, after a preliminary trial, and has been in working order for some time. In order better to illustrate the importance of these researches we take the liberty of altering the figures in order to give the results in round numbers for the whole area of Paris within the fortifications. The surface is about 80,000,000 square metres. In February 1876 the quantity of atmospheric water was 4,500,000 cubic metres. This is about double the average, but in some years on record the quantity was even larger, in 1776 a century ago, it was more than 6,500,000 cubic metres. In taking as an average the analyses of rain-water at Montsouris, the 4,500,000 cubic metres contained 4,700 kilogrammes of nitric acid and 10,700 kilogrammes of ammonia. This mass of nitric acid is supposed to have been produced by electrical reactions in the atmosphere, and ammonia only partly, as Montsouris is in the southern part of the city, close to the fortifications.

The 4,500,000 cubic metres of rain water were also proved to contain 172,000 kilogrammes of organic matter, and 88,400 kilogrammes of metallic salts or products. A number of organic matters have been found

to be composed of spores, parts of animalculæ, and even living infusoriæ. Amongst the metallic salts we must mention particles of meteoric iron, evidently of cosmic origin. It is contemplated by the city of Paris to establish similar observations in several parts of the city, and the careful comparison of these analyses will prove invaluable for establishing a number of most interesting facts having a bearing on the welfare of inhabitants, as well as on the elucidation of important scientific problems.

It is also contemplated to make use of aëronautical ascents to test the air at any altitude accessible to a balloon with horizontal glass plates covered with glycerine. The moisture of the clouds is to be condensed on glass tubes which will be refrigerated.

The ozone testing and measuring has produced also startling facts. Although the quantity of ozone is very minute, amounting to only a few milligrams per 1,000 cubic metres, it has been proved that on Feb. 27, the day of the ozone maximum, a quantity of 900 kilog. was floating over Paris, if we suppose that the quantity was the same as at Montsouris in the whole stream of air passing above up to the altitude of 1,000 metres.

These results are only a sample of those which may be expected from the constant application of the magnificent system which is now brought into operation for the first time, and of which it will be possible to say, *Vires acquirit eundo.*

W. DE FONVIELLE

NOTES

THE following are the arrangements for the Free Lectures in connection with the Loan Collection of Scientific Apparatus for the next few weeks. The lecture hour is eight P.M. Saturday, June 17, Mr. W. H. Preece on Telegraphic Instruments; Monday, June 19, Mr. Kempe on the Application of Linkages to Machinery; Saturday, June 24, Capt. Abney, F.R.S., on Photographic Printing Processes; Monday, June 26, Dr. Schuster on Ampère's and Faraday's Instruments; Saturday, July 1, Mr. W. C. Roberts, F.R.S., Graham's Apparatus and what he did with it; Monday, July 3, The Right Hon. Dr. Lyon Playfair, C.B., F.R.S., Otto von Guericke's and Black's Instruments; Saturday, July 8, Dr. Gladstone on the Instruments lent by the Royal Institution.

ON the 1st inst. the Society of Arts of Geneva celebrated the first centenary of its existence. Founded in 1776 by H. B. De Saussure and some of his friends, it has continued ever since to render real service to Switzerland in the departments of Arts, Industry, Commerce, and Agriculture. Without having any direct connection with science, it has always, however, been associated with it, and all the scientific men of Geneva have from time to time taken a share in its proceedings; the Pictets, De Candolles, De la Rives, and other well-known names, have at various times been presidents. A prize founded by Aug. De la Rive, to be awarded to the discovery most useful to Genevese industry, is intrusted to the care of the Society. In order worthily to celebrate the centenary, the Society had announced various competitions in the different branches with which it is connected, and which appealed to all manufacturers of horological instruments. The nature and terms of this competition we announced last October (vol. xii., p. 525). It was an international competition in chronometry, in which there was a large number of competitors, and of which the results have been now made known. A Prize of Honour was awarded to M. Ulysse Nardin, of Locle, Neuchâtel; six equal First Prizes were awarded to M. H. R. Ekegrin, of Geneva, Messrs. Parkinson and Frodsham, of London, Messrs. Badollet and Co., Geneva, Bredard et Fils, Geneva, M. Ed. Perregaux, of Locle, and M. Fritz Piguet, of Geneva; other awards were likewise made. After the general meeting and the distribution of prizes, a banquet was held, at which about four hundred members of the Society were present; this was followed by a conversazione on the terrace of M. Th. De Saussure, grandson of the celebrated naturalist, the founder of the Society, on the very place where the first meeting was held a century ago.

AT the meeting of the Royal Geographical Society on Monday, Sir Rutherford Alcock, the new president, in the chair, a paper by Mr. E. D. Young, R.N., was read, on a journey to the northern end of Lake Nyassa. The cruise round Lake Nyassa had occupied a month, and the area was much larger than Dr. Livingstone thought, the north end extending to 9·20 S. lat. In most parts it was very deep, and in several places no bottom could be found with 100 fathoms of line. A range of mountains nearly 100 miles in length, extended above the lake, some reaching an elevation of 10,000 or 12,000 feet. There were also numerous rivers running into the lake, but none navigable for any distance. At some parts there were numbers of villages built on piles in the lake; many people in other parts living on barren rocks. Mr. Young added that he intended to be back to England in a few months, and would in the meanwhile make a more perfect survey of the lake and give the results to the Geographical Society on his return. A paper on "The Valley of the Tibagy, in Brazil," by Mr. T. B. Wither, C.E., was also read. The author of the paper was engaged in conjunction with others, in August, 1871, in exploring that section of the Ivahy Valley which lies between Colonia Theresa and the Corredeira de Ferro, or "Iron Rapid."

THE University of Oxford proposes to confer the degree of D.C.L upon the following, among others:—Prof. W. H. Miller, F.R.S., Prof. J. Clerk Maxwell, F.R.S., Dr. Samuel Birch, and Lieut. V. L. Cameron.

THE Oxford University Bill was read a second time in the House of Commons on Monday. In the debate which followed there was nothing worthy of comment.

THE annual conversazione of the Society of Arts will be held at South Kensington Museum on Friday, the 23rd inst.

IN a recent issue of the Italian medical journal *L'Imparziale* laments that the unjust and ridiculous accusations of a number of strangers resident in Florence and of an exceedingly small minority of the inhabitants should have induced Prof. Schiff to accept the chair which has been offered to him at Geneva. The loss to physiology in Italy will be so great that, according to a communication in the *Daily News*, the *Bersagliere* believes that the Minister of Public Instruction will use every endeavour to make the illustrious physiologist withdraw his resignation.

EXCELLENT accounts have been received from the German North Asiatic Expedition, which has arrived as far as Semipalatinsk, in Siberia, and has obtained living specimens of the large Argali sheep (*Ovis ammon*) of Linnæus.

THE veteran ornithologist, Dr. Hartlaub, has in preparation a new work upon the Ornithology of Madagascar and the adjacent islands. Since Dr. Hartlaub's original memoir on this subject was published in 1861, since which time Pollen, Van Dan, Crossley, Grandidier, and others, have done much to increase our knowledge of the avifauna of Madagascar.

WE hear from Sidney that the sum of 800*l*. had been raised towards Signor D'Albertis' expedition up the Fly River, New Guinea; and that he was intending to start from that city on the 19th of April with the steam-launch loaned to him by the Government of New South Wales.

WE regret to hear that the strife at Sidney about the dismissal of Mr. Krefft from the post of Curator and Secretary of the Australian Museum is not over. The subject came before the Legislative Assembly on the 6th of April, and provoked an

angry discussion. Mr. E. P. Ramsay has been installed by the trustees as Mr. Krefft's successor, and is in full work; but the Supreme Court has decided that the trustees had no real authority to remove Mr. Krefft. Whatever the issue may be, everyone acquainted with the case must hold that Mr. Krefft deserves fair and liberal treatment as one of the few naturalists in Australia that have done good original work in spite of many surrounding difficulties.

ON June 7 a violent thunderstorm occurred at Valbonne, a large plain at a little distance from Lyons. The only objects struck were huts full of soldiers and arms, and the occurrence furnishes a good instance of the "power of points" and the attracting power of metals and living beings for lightning. Three tents were struck in succession. The occupant of the first was absent at the moment, and the effects were relatively slight, producing only the breaking of stones and dispersing of dust. In the second instance a soldier who was standing erect in front of one of the tents was struck; but the tent being located in the vicinity of an electric telegraph the lightning escaped by it, fired the wires, and broke a dozen poles. This may suggest a very easy method for protecting an encampment. The third flash struck a number of tents placed in a zig-zag line, doing much damage, several of the occupants being either killed or wounded. In one tent three men were killed and seven wounded. All of them were either touched in both legs or on the right side except one, who was wounded in the right eye. In another tent four men were wounded, all of them in both legs or in the left one. In other instances men were turned round in or heaved out of their beds. In all the instances referred to the men were lying on their beds, made of iron, and the sentry standing in front remained unhurt. In one tent a man, who was lying between two men who were killed, escaped unhurt. The uniforms of the soldiers were perforated and exhibited small spots; one, four centimetres in diameter, entirely sulphurised. A chemical analysis will be made of this part of the uniform, and the result communicated to the Academy of Sciences.

AT a meeting of the Cymmrodorion Society held last Friday, in the Memorial Hall, Farringdon Street, Prof. F. W. Rudler, F.G.S., read a paper on "Natural History Museums, with Suggestions for the Formation of a Central Museum in Wales."

THE boring of the shafts for the Anglo-French tunnel is progressing favourably. A pump has been erected for the draining of the works. Water has been already met with in abundance, although the depth reached is only 40 feet. The intended level is 60 feet further down.

THE Edinburgh Town Council, it is stated, have agreed to apply to the Government for aid to the building fund of the University extension scheme, and to memorialise in favour of a parliamentary grant. The Council had previously subscribed 1,000 guineas to the fund on their own account.

THE Geographical Society of Paris has received good news from the Gaboon expedition. Lieut. Brazza and M. Marche have located themselves at Okanda, 500 miles from the mouth of the Ogowe, and are establishing permanent settlements and ready means of communicating with the factories on the coast. They lost a part of their baggage and goods in crossing rapids, but having been enabled to send messengers to the French Gaboon settlement they will recover from their losses and will proceed further in the untrodden region.

ON June 8 the French Society of Amis des Sciences held its annual meeting at Paris. M. Bert gave a lecture on the *Zenith* balloon catastrophe in connection with the inhalation of oxygen. This Society was founded by the Baron Thenard for assisting scientific men in their work and their families after their death.

THE French Society for Encouragement of National Industry had to vote this year the great Prony prize for the most useful invention in mechanics discovered during a certain number of years. The award was made to M. Henry Giffard, of Paris, the aëronaut, for the invention of his injector, used in all locomotives. The invention is fifteen years old, and the patentee has realised through this his single invention a fortune falling very little short of half a million sterling.

WE take the following from the *Geographical Magazine*:—Dr. P. Ascherson left Benisuef for Medinet-el-Fayum, on March 16, and started from the latter place on the 24th, *en route* for the Little Oasis, the botanical exploration of which constituted the object of his journey. On April 1 he reached Bauiti, the present capital of the Oasis parva, by the same route as that followed by Belzoni in 1816. This journey proved that no "Bahr bela ma" or old river-bed exists in that portion of the Libyan Desert. After an exhaustive exploration of the oasis, Dr. Ascherson started on May 1 on his return journey, travelling by an entirely new route, and reaching the Nile at Samalut. The botanical exploration of the oases of the Libyan Desert begun two years ago by Dr. Ascherson, whilst a member of Rohlf's expedition, has thus been terminated, and several facts of great interest have been ascertained during this last journey as regards the Fayum, as well as the Little Oasis. Several species of plants, met with far to the east and south-west, in Asia, but not in the Valley of the Nile, or in the deserts to the east of it, occur also in the oases. Some of the more remarkable of these plants are *Dianthus Cyri*, *Populus euphratica* (= *P. diversifolia* of Mongolia), and *Prosopsis Stephaniana*.

THE Society of Ethnology of Paris has proposed, for 1876, a prize to the best memoir on "The Slavonic Race, and Maps of the Countries inhabited by Slavonians." The prize will be awarded in December, and the memoir may be written in English as well as in French and in several other languages, not excluding Polish and Russian.

THE twenty-fifth Annual Educational Conference of the Society of Arts will take place on June 23, at 11 o'clock. The chair will be taken by Sir Henry Cole, K.C.B. With the view of giving special interest to the Conference this year, the Council have decided that the subject of adult education, especially in reference to technical instruction and its promotion by the action of the Government, shall form the principal subject for discussion.

PROF. E. QUETELET has written a brief notice in the *Bulletin* of the Royal Academy of Belgium, of the storm of March 12, 1876, which was the most violent hitherto observed at Brussels, the wind having reached the enormous pressure of 144 kilogrammes per square metre, or nearly 30 lbs. per square foot, and the barometer fallen to 28·560 inches at sea-level, having only once fallen below this point since the founding of the Observatory in 1833. We are glad to see that Dr. Buys Ballot is also examining this remarkable storm, which he will be able to do very fully owing to the number of registering barometers in operation at the Dutch Meteorological Stations.

IN the *Supplemento alla Meteorologia Italiana*, anno 1875 fasc. ii., there appears a very valuable paper, by P. F. Denza on the distribution of the rainfall in Italy during 1872. The paper, which is one of great ability, details the rainfall of tha year, comparing it where possible with the averages of pas years; and in consideration of the singular diversity with seaso of the rainfall of the different parts of Italy, the stations ar classed according to five zones, viz., Alpine, Pre-alpine, Ea Apennine, West Apennine, and Sicilian. The details of tl great rains of October 1872 are very interesting, the amou for the month being 40 inches at Pallanza, 41 inches at Crabbi

If the object is merely to raise water this can be done without the employment of either water-wheel or turbine. When a small quantity is required to be raised to a considerable height the Montgolfier ram is employed. No. 1,996, which I have before me, is a glass model of such a ram, but I fear it is too small to be visible, except to those who are very near to the table. You are, however, all aware that the principle of action consists in the sudden arrestment of a column of water flowing with a velocity due to the head. The water on being arrested performs two functions, a small portion raises an outlet valve, and thereby passes into an air-vessel against a pressure competent to drive the water up to the desired height; while the main body recoils along the supply pipe; then, the escape valve having opened the water that has recoiled, returns, a large portion passes out of the valve, and thus the velocity being fully established the escape valve shuts and causes another arrestation and a repetition of the working. This is an implement by which a large volume of water coupled with a low fall, can be made to raise a portion of itself to a great height. But there is a converse use of water, wherein the employment of a small stream of water moving rapidly (owing to its having fallen from a considerable height) is caused to induce a current in other water and to draw it along with itself at a diminished velocity but still with a velocity competent to raise the united stream to a less height, and in this manner many swamps and marshy lands have been drained.

This employment of the induced current as a prime mover is described by Venturier in the record of his experiments made at the latter end of the eighteenth century, and within the last few years Mr. James Thomson has applied the same principle with great success in his jet pump.

The next mode I shall notice of obtaining motive power from water, is also one where it operates by an induced current; this is the "Trombe d'eau," an apparatus wherein water falling down a vertical pipe, induces a current of air to descend with it. The lower end of the vertical pipe being connected with the upper side of an inverted vessel, the bottom of the sides of which vessel is sealed by a water joint, then the water dashing upon a block placed below the mouth of the pipe, is separated from the air, so that while the water descends and escapes from under the sides of the vessel, the air rises and accumulates in the upper part from whence it can be led away to blow a forge fire. These machines are described in Belidor's work.

The utilisation of the rise and fall of the tide is also fully described by Belidor, who gives drawings of channels so arranged that during both the rise and fall of the tide the wheel, notwithstanding the reversal of the currents, revolves in one and the same direction. The tide is a source of power which it is highly desirable should be utilised to a greater extent than it is; if we consider the enormous energy daily ebbing and flowing round our shores, it does seem to be a matter of great regret that this energy should be wasted, and that coal should be burnt as a substitute.

The last mode in which power may be obtained from water, to which I have to allude, is that of the employment of the waves.

Earl Dundonald, better known as Lord Cochrane, proposed by his patent of 1833 to utilise this power for propelling a vessel; this he hoped to accomplish by the use of cylinders containing mercury, the oscillations of which were to cause a vacuous condition in the cylinders, and thereby give motion to an air-pressure engine. Lately we have had produced before the Institution of Naval Architects, and also before the British Association at Bristol, the apparatus of Mr. Tower, by which the motion of the waves is to be utilised; a model constructed on this principle has driven, it is said, a boat against the wind at some two or three miles an hour.

The next kind of prime-movers in order of date to be considered, are those that are worked by the wind.

Although undoubtedly the propelling of a ship by sails, and even the winnowing of grain, must have long preceded the invention of a prime mover driven by water, yet the employment of the wind as a source of motive power for driving machinery, appears to be but of comparatively recent date. It is said that the knowledge of this kind of prime mover was communicated to Europe by the Crusaders on their return from the East, but it is difficult to see what foundation there is for this statement. It appears to be certain, however, that wind-motors were commonly employed in France, Germany, and Holland in the thirteenth century.

We can easily understand that in countries where water falls [illegible] streams are abundant, the windmill would not, owing to its uncertainty, be resorted to; on the other hand, in inland countries and in countries like Holland, where the streams are sluggish, and where there is a large amount of land to be drained, the wind, although still uncertain, would nevertheless be a valuable power, and therefore would be utilised.

Prime movers to be worked by the wind appear to have been made practically in only two forms, viz, the common one, wherein a nearly horizontal axle carries four or more twisted radial sails, and that one wherein the axle is vertical and the arms project from it laterally either as radial fixed arms, as curved fixed arms, or as arms having a feathering motion similar to that of paddle-wheels. Where the arms are straight and fixed, some contrivance must be resorted to to obtain a greater pressure of wind on one side than on the other.

Bessoni, in his work "The Theatre of Instruments and Machines," published at Lyons in 1582, describes a windmill with vertical spindle and curved horizontal arms, placed in a tower with a wind-guard, and by the drawing shows it working a chain-pump. Belidor also says, in Article 852 that windmills with vertical axles were well known in Portugal and in Poland, and he describes how that they work within a tower the upper part of which was fitted with a movable portion to act as a screen to one side of the mill.

I will not detain you by an allusion to the sailing chariot mentioned by my Uncle Toby in "Tristram Shandy," nor will I pause to describe the very modern one, that is to say, not more than about thirty years old, which was employed upon Herne Bay Pier. In fact this Exhibition gives but little encouragement to pursue the subject of prime-movers worked by wind, as I have not as yet come across in the Catalogue any apparatus illustrative of the subject.

It is to be regretted that the use of this kind of prime mover, the windmill, is on the decline. It is a power that costs nothing; the machinery can be erected in almost any situation; and although such a motor cannot by itself be depended on, being of necessity "as uncertain as the wind," it nevertheless might be commonly employed as an auxiliary to steam-power, diminishing the load upon the engine in exact proportion as it was urged by any wind which might happen to blow.

I may say, to the credit of our American brethren, that they employ on their sailing-ships a windmill known by the sailors as "The Sailor's Friend," to pump, to work windlasses, and to do all those matters which in a steam ship fall to the lot of the donkey-engine and steam winch, unless, as in a recent voyage in which all Englishmen have been so much interested, these duties were imposed upon the baby elephant.

There is one motor which may be put either into this class or into the next, where we consider the application of heat; I allude to the smoke-jack, but beyond recognising its existence as a prime mover, and a very early one indeed (it is to be found in Zoncas' work published in 1621), attention need not be bestowed upon it.

We now come to consider those prime movers which are worked by the immediate, and not by the secondary, action, of heat.

The direct rays of the sun have, for a very long time past been suggested as a means of obtaining motive power. Solomon de Caus in his work, published in 1615, describes a fountain which is caused to operate by the heat of the sun's rays expanding the air in a box and expelling the water by, through a delivery valve, the water from the lower part of the box. When the sun's rays have been withdrawn, the air, cooling, contracts, the suction valve, opens and admits more water into the box to be again displaced on the following day. He also gives a drawing of an apparatus where the effect of the sun's rays is to be intensified by a number of lenses in a frame. Solomon de Caus proposes these machines as mere toys to work an ornamental fountain, but Belidor, by Article 827, describes and shows a sun pump consisting of a large metallic sphere, fitted with a suction pipe and valve, and a delivery pipe and valve and occupied partly by water and partly by air, the suggestion being as in the case of Solomon de Caus, that the heat of the sun in the daytime expanding the air should drive the water into a reservoir, while the contraction of the air in the night-time should elevate the water by the suction pipe and charge the sphere for the next day's work. In modern times, we know, some attempts to obtain practical motive power from the direct action of the sun have been made, and notably by Capt. Ericsson.

The temptation to endeavour to bring into practical use a machine of this character is very great. We were told by

President, in a lecture delivered by him to the British Association at Bradford, that the solar heat, if fully exercised all over the globe, supposing that globe to be entirely covered with water, would be sufficient to evaporate a layer 14 feet deep of water per annum. Now assuming 10 lbs. of water evaporated from the temperature of the air into steam by the combustion of 1 lb. of coal (a much larger result than unhappily is got in regular work), this would represent an effect obtained from the sun's rays on each acre of water equal to the combustion of 1680 tons of coals per annum, or to about 92 cwt. of coal per acre per twenty-four hours; or enough to maintain an engine of 200 gross indicated horse-power day and night all the year round. When, however, we consider the effect of the sun, not upon the surface of water but upon the earth, and deal with its power of producing heat-giving material, the result compares very unfavourably with the work done by the sun itself; and this, no doubt, arises first, from the fact that the sun is frequently obscured, and second, from the fact that a large portion of the energy of the sun is spent in evaporating moisture from the ground, and not in the direct production of combustible material. I have found it extremely difficult to obtain any reliable data as to the weight of fuel grown per acre per annum. If we take the sugar cane, we find that in extremely favourable cases as much megass and sugar together are produced as would equal in calorific effect about five tons of good Welsh coal. Coming to our own country and dealing with a field of wheat, the wheat and straw together may be taken as being equal probably to about two tons of coal as a maximum. The statements made to me with regard to the production of timber per acre per annum, when grown for the purpose of burning, are very various; but the best average I can make from them is that in this country there is produced as much wood as is equal in calorific effect to about 1½ tons of good coal per acre. Comparing these productions of heat-giving material with the energy of the sun, as shown in the evaporation of water, one shows how tempting a field is that of the direct employment of the solar rays as a source of power; more especially, when it is remembered that those rays are obtained from week to week, and year to year, without having to wait the tardy growth of the fuel-destined tree.

I will now ask you to consider with me the prime movers that owe their energy to the heat developed by the combustion of some ordinary kind of fuel—coal or wood. Passing by as a mere toy and not an actual prime mover, the reactionary steam sphere, the eoliopile of Hero, I will come at once to those simple forms of heat-engine (whether worked by steam or the expansion of air), by which water was to be raised. Solomon de Caus, in his work of 1615, already mentioned, says that if you fill a globe with water and have in its upper part a pipe dipping nearly to the bottom, and if you put the globe upon the fire the heat will cause the expansion of the contents, and the water will be delivered in a jet out of the tube.

The Marquis of Worcester in his "Century of Inventions," published in 1659, makes, as is well known, a similar proposition, but it does not appear that these machines were seriously contemplated for practical use. Papin (I take Belidor's Article No. 1,276 as my authority) in 1698 (as appears in his pamphlet of 1707) experimented by order of Charles the Landgrave of Hessen Cassel with the view of ascertaining how to raise water by the aid of fire. But his experiments were interrupted and he did not resume them until Leibnitz, by a letter of Jan. 6, 1705, called his attention to what Savery was doing in England, sending him a copy of a London print of a description of Savery's engine. This engine, which of course is well known to you, is illustrated by a model in this collection, and now on the table before me. Savery employed a boiler, the steam from which was admitted into a vessel furnished like the sun-pump of Belidor with a suction pipe and clack and a delivery pipe and clack; the steam being shut off, cold water was suffered to flow over the vessel, a vacuum was made and water raised into the vessel, which was expelled out of the delivery pipe upon the next admission of steam, the cocks being worked by hand. This machine came into very considerable use and was undoubtedly the first practical working steam-engine. It had, however, the defect of consuming a large quantity of steam, as the steam not only came into contact with the cold vessel but also with the surface of the water in that vessel. Papin, as we know, obviated a portion of his loss by the employment of a floating piston placed so as to keep the steam from actual contact with the surface of the water.

We have in the collection, No. 2,007, a cylinder from Hessen Cassel, said to be of the date of 1699 and to have been intended for employment in Papin's machine, but it is difficult to say for what part of the apparatus it could have been designed, inasmuch as the cylinder is provided with a flange at one end only and no means, so far as I can ascertain, exist for closing the other end. You will see from the diagram that which no doubt is already well known to you; Papin did not propose to condense the steam, and by its condensation to "draw up" the water (to use a familiar expression) but intended that the vessel should be charged by a supply from above, and, that the steam should be employed only to press on the floating piston and to drive the water out. Papin, however, hoped to use his engine, not merely as a water-raiser, but as a source of rotary power by allowing the water to issue from the air vessel, so as to impinge upon the pallets of a water-wheel and thus produce the required revolution.

(To be continued.)

SCIENTIFIC SERIALS

American Journal of Science and Arts, May.—Mr. Holden here collates various observations made on nebula M 17 (the figure of which is like that of a Greek capital Omega) from 1833 to 1875. The drawings show that the western end has moved relatively to its contained stars, and always in the same direction. It may be a veritable change in the structure of the nebula itself or the bodily shifting of the whole nebula in space.—Mr. Trowbridge states that the application of thin plates of soft iron on the poles of two straight electro-magnets, with bundles of fine iron wires for cores, increases the strength of the spark at the poles of two secondary coils surrounding the electro-magnets, 400 per cent. The length of the spark is increased 100 per cent. (but this is only manifested by using Leyden jars of large capacity with the secondary circuit). Instead of distributing the fine wire of a Ruhmkorff coil on a straight electro-magnet, as at present, it should be distributed equally on two straight electro-magnets whose poles are provided with armatures of bundles of thin plates of soft iron.—Mr. Wilson having applied infusorial earth to land sown in wheat, afterwards treated some of the wheat straw with nitric acid, and found that the siliceous remains consisted almost wholly of the shields of diatomaceæ, the same as found in the infusorial earth (only the larger discs, in their perfect form, being absent). It would appear that simple or compound silicates are useless as fertilising agents, and that silica can enter the plant only in the free state.—In the first portion of a paper on the solid carbon compounds in meteorites, Mr. J. Laurence Smith, after noting that in carbonaceous meteorites the mineral constituents are mainly the same as in the so-called common type of meteoric stones (viz., olivines, and pyroxenes, differing only in the more or less compact form of these minerals), shows, that even in the carbonaceous constituent they are strongly linked even to the iron meteorites.—Mr. Fontaine continues his account of the conglomerate series of West Virginia; Mr. Dana describes new forms of staurolite and pyrrholite; and we also find chemical notes on phosphorus oxychloride, and the oxydation product of glycogen with bromine, silver oxide, and water.—A simple and very accurate method of testing the unison of two forks is (according to Mr. Spice) by holding them *together* over their proper resonant column; if the forks be *very* nearly in tune, beats will be perceived succeeding each other at long intervals, or the sound will merely swell out again very slightly after it has nearly died away. When the forks are absolutely alike, there will be a gradual decrease of sound down to silence, without any reinforcement at any time.

THE *American Naturalist* for May commences with an article by the Rev. S. Lockwood, on Animal Humour. Prof. Asa Gray writes on Wild Gooseberries. Hon. J. D. Cox describes multiplication by fission in *Stentor mulleri*. An article on Primitive man follows, after which Mr. A. S. Packard, jun., describes and figures the Cave-beetles of Kentucky. Prof. Farlow writes on University Instruction in Botany. General Notes and a few short reviews follow, the number being completed by notes and notices of meetings.

Zeitschrift der Oesterreichischen Gesellschaft fur Meteorologie, March 1.—This number contains a long article on the relations of temperature and moisture in the lowest atmospheric strata during the formation of dew, by Dr. R. Rubenson, of Stockholm. Observations made by Dr. Hamberg, at Upsala, on temperature at different heights on frosty nights led him to conclude that in the lower strata temperature increases with height, and that the

absolute moisture is less on the ground than a few feet above it. The chief results obtained by Dr. Rubenson during the summer of 1871, by a method of observation differing from that of Dr. Hamberg, may be summed up as follows:—Before the fall of dew the absolute moisture continues to increase and is greatest on the ground, diminishing with height. As soon as dew begins to fall, moisture decreases on the surface of the ground, and this decrease keeps pace with the decrease of temperature. The decrease of moisture extends upwards rather rapidly, and can be detected at four feet just after the first deposition of dew. On the ground the decrease per hour amounts to a maximum of about 0·73 mm., while half a foot above it the decrease only reaches 0·65 mm., which is less than one corresponding to the lowering of temperature. The higher the instrument the later does the decrease of moisture show itself, and the less the change per hour. It appears that owing to a fall of temperature on the ground, the air immediately above it becomes saturated, dew falls, and temperature and moisture diminish. At a certain point, owing either to diffusion or a descending current, fresh vapour supplies the place of that condensed as dew, and part of the loss of each stratum is successively made up by the moister stratum above it, but not the whole, for the diminution continues in all the strata. Time being required for the propagation of the decrease upwards, the lowest stratum loses more of its moisture than any of the strata above it.

Zeitschrift für Wissenschaftliche Zoologie, 1875. 2nd Supplement.—This part contains a memoir by Oscar Schmidt, on the embryology of calcareous sponges, in which Haeckel's observations and conclusions are attacked, and his Gastræa theory is destroyed, as far as calcareous sponges are concerned. Unfortunately, at a critical point Oscar Schmidt failed to follow his embryos, and the real purport of his observations remained uncertain until the publication of Schulze's researches hereafter mentioned.—Dr. William Marshall contributes a long memoir on the hexactinellid sponges, figuring and describing new species, with their characteristic spicula. His most interesting new form is one in which the central cavities of the spicula coalescing to form the meshes of the skeleton become perfectly continuous by their protoplasmic contents.

The 3rd Supplement (1875) commences with F. E. Schulze's memoir above referred to, on the structure and development of *Sycandra raphanus*. His beautiful figures give the various stages of segmentation, and the arrangement of the segmentation spheres into groups of different sizes, one set of these giving rise to the invagination by which the Gastrula form is constituted. This sponge is now accepted by Haeckel as exemplifying his Amphiblastic type, while other calcareous sponges form archiblastic embryos, in which the segmentation spheres remain similar to one another until after the Gastrula is formed.—August Weissmann contributes a philosophical paper on the transformation of the Axolotl into Amblystomas. He believes that this transformation is to be regarded as a retrogression, and that the present Axolotl represents a former Amblystoma whose structure has been modified by changed conditions of life.—Prof. Nitsche continues his valuable memoirs on the Bryozoa, the present instalment being devoted to the process of gemmation. He shows that all the structures in the new zooid are produced from the ectoderm of the parent, and insists on the important morphological consequences of this fact, while deprecating the precise schemes of embryogeny and phylogeny now so much in vogue.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 11.—On Simultaneous Barometric Variations in India, by J. A. Broun, F.R.S.—After Pascal showed that the mercury in the barometer tube stands lower at the top than at the foot of a mountain because the mass of air above the barometer is less in the former than in the latter case, it was a natural conclusion that the variations in the height of the mercury observed with a stationary barometer are due to the same cause. Various hypotheses have been proposed to explain how the aërial mass is increased or diminished, none of which, however, can satisfy the facts now known, being either insufficient or untrue. The author, after referring to the latest of these hypotheses, gives results which he has deduced from observations made at three stations in India; namely, at Simla, 7,000 feet above the level of the sea, on a spur of the Himalayas, at Madras, and at Singapore, near the sea-level, the last being 2,700 miles from the first, and 1,800 miles from the second station.

When the daily mean height of the barometer is taken, a large movement is found occupying nearly twenty-six days, a movement attributed by the author to the sun's rotation on his axis; but it is the smaller oscillations of the daily mean atmospheric pressure, the secondary maxima and minima, which are especially examined. The present discussion has been limited to three months, during which there were eighteen of these maxima and minima. The author finds that the mean interval between the times of maximum pressure at any two stations is less than seventeen hours, and between the times of minimum pressure less than ten hours. In four out of eight cases of minima the lowest pressure was attained at all the three stations within six hours. The results of these comparisons is shown to extend even to St. Helena.

It was pointed out that though in general maxima and minima happened at the three stations near the same hour, there were one or two marked exceptions to the rule; one of these, a fall in the height of the mercury of three-tenths of an inch within thirty-six hours, at Simla, was not perceived at any of the other stations. This, the greatest of all the disturbances of atmospheric equilibrium during the period examined, was shown to be connected with a great thunderstorm at Simla (not felt at the other places), and was thus due to a local cause, while the other variations, some of about one-thirtieth the amount of that just mentioned, happened nearly simultaneously over an area of at least a million square miles.

The author suggests that another cause is required to explain these facts than variations of mass through thermic or other actions, the whole climatic conditions being different at the various stations; in other words, *that the attraction of gravitation is not the only attractive force concerned in the variations of atmospheric pressure.*

Linnean Society, May 24.—Annual General Meeting.—Prof. Allman, F.R.S., president, in the chair.—There were presented by Mrs. J. J. Bennett, and a vote of thanks accorded, three medals, memorials of Linnæus—one of silver, struck in 1746, given by Linnæus to Haller in exchange for his portrait; one of gold, dated 1747, struck at the expense of Count Tessin; and a large silver one, designed by Lynberger, struck by command of the King of Sweden in commemoration of the death of Linnæus, Jan. 10, 1778.—Mr. J. Gwyn Jeffreys, treasurer, read his statement of the accounts, &c., of the Society for the year 1875. These showed its financial position to be very favourable, and, indeed, prosperous. The increase in the number of Fellows was very marked, and everything augured the Society's retaining their well-earned reputation and usefulness as a scientific body.—The President then delivered his anniversary address, choosing as a topic the department of biology, treating of those remarkable forms, the border-land between vegetable and animal life. He began by allusion to De Bary's researches on Myxomycetes and its curious transformations; then referred in detail to Cienkowski's remarkable observations on Vampyrella and the marine sarcodous organisms, Labyrinthulæ. Dr. Archer's Chlamydomyxa, Haeckel's Myxastrum, and Magosphaerica, were each passed in review, and a comparison of all these forms entered into, with their peculiar phases and relations to each other. He observed that in them protoplasm was reduced to its simplest nature, evincing what might be considered vegetative or animal life, according to stage, &c. He summed up by regarding life as a property of protoplasm, but very different from conscience and will, or indeed any of the psychological phenomena. The following Fellows were elected into the Council:—J. G. Baker, Dr. W. P. Carpenter, Henry Lee, Prof. W. K. Parker, and S. J. A. Salter, M.B., in the room of the subjoined, who retired: W. T. T. Dyer, J. E. Harting, W. P. Hiern, M.B., Dr. J. D. Hooker, C.B., and J. J. Weir.

Chemical Society, May 18.—Prof. Abel, F.R.S., president, in the chair.—A paper on hemine hematine and a phosphorised substance contained in blood corpuscles, by Dr. J. L. Thudichum and Mr. C. T. Kingzett, was read by the latter.—Prof. W. N. Hartley then made a communication on the natural carbon dioxide from various sources, being a continuation and extension of his former paper on the presence of liquid carbonic anhydride in the cavities of quartz and other minerals.—Mr Kingzett subsequently read a note on some trials of Frankland and Armstrong's combustion process *in vacuo*, by Dr. Thudichum and himself.—Mr. T. Fairley gave a short account of three papers on

peroxides, in which he described various reactions with hydrogen peroxide, and also the preparation of sodium and uranium peroxides, on chromic and perchromic acids, and on the estimation of nitrogen.—The Secretary read a paper, by Prof. J. W. Mallet, on aluminium nitride and the action of aluminium on sodium carbonate at a high temperature. The nitride forms small crystalline particles of a yellow colour.—Lastly, Mr. E. Neison gave a short account of a process for the estimation of mercury.

Royal Astronomical Society, May 12.—Mr. W. Huggins, president, in the chair.—The Rev. Frederick Howlett presented to the Society five volumes of sunspot drawings made between the years 1859 and 1874. They contain several drawings of sunspots on a large scale, some of which have already been figured in the pages of the *Monthly Notices*, and other places. A letter was read from Mr. Birmingham informing the Society that Dr. Schmidt's great lunar map of six French feet diameter will soon be issued by the Prussian Government. It has been the labour of thirty-four years, and contains 34,000 craters besides rills and other objects.—A paper by Mr. Dunkin was read on the conjunction of Venus with λ Geminorum, on August 18, 1876, when there will be an excellent opportunity for making micrometrical measures of the planet's parallax with respect to the star. Its nearest approach will be seen from stations in North and South America a little before sunrise.—A paper by Mr. Hind was read on the transit of the great comet of 1819 across the sun's disc. The transit happened on its approach to perihelion, and the comet was not observed until some days afterwards, when it was receding from the sun. After a few weeks Olbers calculated the elements of its orbit, and announced the fact that on the previous 26th of June it must have passed at its ascending node between the earth and sun. Some five years afterwards Pastorff wrote to the Baron de Zach to inform him that he had seen the comet upon the sun's disc, and had, upon the day of its transit, made a drawing of it and a measure of its distance from the sun's limb. He describes it as a nebulous body 6′ in diameter with a bright centre. His original drawing is preserved in the library of the Astronomical Society. Mr. Hind has carefully recalculated the elements of the comet's orbit, and has found that at the time mentioned by Pastorff the comet must have appeared much nearer to the sun's centre than the position indicated by Pastorff. Canon Stark of Augsburg, also published an account of a nebulous body seen upon the sun's disc at 7h. 5m. on the morning of June 26. The measures given by him of the position of the black spot do not agree with the position calculated by Mr. Hind, although there is less discrepancy between them and the calculated position than there is in the case of Pastorff's observation. Mr. Hind is disposed to think that neither Stark's nor Pastorff's observations are to be depended upon.—Mr. Christie read a note on the displacement of lines in the spectra of stars, from which it appeared that the discrepancies between the results of his observations and those of Mr. Huggins only amounted in the case of most of the stars which had been given by him to some three or four miles per second. The meeting adjourned till June 9.

Geological Society, May 24.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—The following communications were read:—"On the old glaciers of the northern slope of the Swiss Alps," by Prof. Alphonse Favre. The author said that in existing glaciers two parts may be recognised,—an upper one, the reservoir or feeding glacier, and a lower one, the flowing glacier. Applying this division to the old glaciers, it appears that in the glaciers of the Rhone and Rhine the flowing glacier which occupied the plain had a surface nearly equal to that of the feeding glacier which was situated in the mountains. He showed (1) that the Rhone glacier passed over several of the chains of the Jura, and that the ice covering these, far from being an obstacle to the extension of the glaciers of the Alps, actually reinforced them, and served them as *relays*, the glaciers of the Jura having carried far on the Alpine erratic blocks; (2) that the slopes of the upper surface were variable, and were null, or nearly so, over considerable spaces. During their greatest extension the Swiss glaciers came in contact with those of central France near Lyons; they united with those of the Jura, the Black Forest, and the Austrian and Italian Alps; they stretched from the plain of the Po to that of the Danube; and further, for distances of 50 or 100 kilometres they nearly approached horizontality. Hence they resembled the glaciers of the interior of Greenland and Spitzbergen, so far as can be judged from the descriptions.—Evidences of Theriodonts in Permian deposits elsewhere than in South Africa, by Prof. R. Owen, F.R.S. In this paper the author noticed some described reptilia which he believes to belong to his order Theriodontia. The genus *Eurosaurus* was founded in 1842 by Fischer von Waldheim upon some fragments of bone, including a humerus with a broad proximal end as in Kutorga's *Orthopus*; and Fischer also noticed a humerus showing characters like those of Kutorga's *Brithopus*, from the same locality as the portion of a jaw described under the name of *Rhopalodon Wangenheimii*, Fischer. In 1858, H. von Meyer described a skull from the Permian of the Oural, under the name of *Mecosaurus uraliensis*, as a Labyrinthodont; and Eichwald referred this genus, with Kutorga's *Brithopus* and *Orthopus*, to Fischer's *Eurosaurus*. The author regarded *Mecosaurus* as truly Labyrinthodont; whilst the Permian forms constituting Kutorga's genus were referred to the Theriodont order. From the same locality as the above Kutorga describes *Syodon biarmicum* as probably a Pachyderm. Its teeth resemble those of *Cynodraco*. Eichwald's *Deuterosaurus biarmicus* is founded upon the fore part of both upper and lower jaws of a reptile, containing teeth with denticulate or crenulate trenchant borders, the canines being large, especially in the upper jaw. *Deuterosaurus* closely resembles *Cynodraco*, and still more the *Lycosaurus* of the Karoo beds of the Sneewberg range. All the above are from the Permian beds of the Oural, and the author regards them as furnishing important evidence of the Palæozoic age of the Karoo series, in which the Theriodont reptiles are best represented. The author further noticed a Theriodont allied to *Lycosaurus* from a red sandstone, probably of Permian age, in Prince Edward Island. The remains include the left maxillary, premaxillary, and nasal bones; the teeth, implanted in distinct sockets, have sub-compressed, re-curved, conical, pointed crowns, with minutely crenulated borders. This fossil has been described by Dr. Leidy under the name of *Bathygnathus borealis*. Thus, supposing the affinities of the fossils from the Oural and Prince Edward Island to be correctly determined, the reptilia distinguished by mammalian characters are shown to have had a very wide range. Further, the author thinks that the Theriodont reptiles of the Bristol Dolomitic conglomerate may also prove to constitute a family in the Theriodontic order.

Physical Society, May 27.—Prof. Gladstone, vice-president, in the chair.—The following candidates were elected members of the Society:—Herbert Taylor, Rogers Field, and Channell Law.—Mr. W. Ackroyd read a paper on selective absorption. Two typical experiments were shown upon which a division of selective absorption may be based. In the first, light is transmitted through bichromate of potash at the normal temperature and again at about 200° C.; and the spectrum of the transmitted light is examined. The widening of the absorption-bands which takes place at the higher temperature is traced to structural alterations. In the second experiment light is sent through two thicknesses of the same coloured solution, as, for example, sulphate of copper, and in the greater thickness the absorption-band has widened out, but this is plainly not owing to any structural alteration. That in the first experiment he proposes to term *structural*, and that in the second *transverse* absorption, and he considers that these two kinds have not hitherto been sufficiently distinguished. Certain colour relations which exist among anhydrous binary compounds led the author to the conclusion that the width of a structural absorption-band bears a direct relation to interatomic distance. The necessity for separating high temperature spectra from low was shown, and the bearing of the subject on the study of organic colouring matters briefly alluded to.—The Secretary then read a communication from the Rev. R. Abbay, on certain remarkable atmospheric phenomena in Ceylon. The most striking of these is witnessed from the summit of Adam's Peak, which is a mountain rising extremely abruptly from the low country to an elevation of 7,200 feet above the sea. The phenomenon referred to is seen at sunrise, and consists *apparently* of an elongated shadow of the mountain projecting westward to a distance of about seventy miles. As the sun rises higher it rapidly approaches the mountain and appears at the same time to rise before the observer in the form of a gigantic pyramid of shadow. Distant objects may be seen through it, so that it is not really a shadow on the land, but a veil of darkness between the peak and the low country. It continues to rapidly approach and rise until it seems to fall back upon the observer, like a ladder which has been reared beyond the vertical, and the next instant it is gone. Mr. Abbay suggests the following explanation of the phenomenon:—The average temperature at night in the low country during the

dry season is between 70° and 80° F. and that at the summit of the peak is 30° or 40° F.; consequently the low strata of air are much the less dense, and an almost horizontal ray of light passing over the summit must be refracted upwards and suffer total internal reflexion, as in ordinary mirage. On this supposition the veil must become more and more vertical, as the rays fall less horizontally, and this will continue until they reach the critical angle, when total internal reflexion ceases and it suddenly disappears. Its apparent tilting over on the spectator is probably an illusion, produced by the rapid approach and the rising of the dark veil without any gradual disappearance which can be watched and estimated. It will be evident that the illumination of the innumerable particles floating in the atmosphere causes the aerial shadow to be visible by contrast. Another interesting phenomenon visible in the mountain districts admits of an equally simple explanation. At times broad beams apparently of bluish light may be seen extending from the zenith downwards, converging as they approach the horizon. The spaces between them have the ordinary illumination of the rest of the sky. If we suppose, as is frequently the case, that the lower strata of air are *colder* than the upper, the reflexion spoken of in the case of Adam's Peak will be downwards instead of upwards. If several isolated masses of clouds partially obscure the sun, we may have several corresponding inverted veils of darkness like blue rays in the sky all apparently converging towards the same point below the horizon. This latter phenomenon is called by the natives "Buddha's Rays."—Prof. Dr. Forel of Morges, Switzerland, then gave, in French, an account of some interesting observations which he has recently made on the periodic waves which take place on the Swiss lakes and are there called "Seiches." It was long since observed that the waters of most of these lakes are subject to a more or less regular rise and fall, which at times have been found to be as much as one or two metres. M. Forel has studied this phenomenon in nine different lakes, and finds that it varies with the length and depth of the lake and that the waves are in every way analogous to those already studied by Prof. Guthrie in artificial troughs, and follow the laws which he has deduced from his experiments. Most of the observations in Switzerland were made on the lake of Geneva, but that of Neuchâtel was found to be best fitted for the study of the subject, possessing as it does an extremely regular geometric form. The apparatus he employed was very sensitive to the motion of the water, being capable of registering the waves caused by a steamboat half an hour after it had passed, and five minutes before its arrival, and was so constructed as to eliminate the effect of common waves, and to register the motion side by side with a record of the state of the barometer, on paper kept in continuous motion. While he found the duration of waves to be ten minutes at Morges it was seventy minutes at Geneva, and this is explained by the narrowness of the neck of the lake at the latter place. This period he proved to be independent of the amplitude, and to be least in the shortest lakes. For shallow lakes the period is lengthened and his observations show that the period is a function of the length and depth and that longitudinal and transverse waves may coexist, just as Prof. Guthrie has shown to be the case in troughs.

Stockholm

Academy of Sciences, March 12.—Herr Rubenson communicated a paper entitled "Monthly and yearly averages of Temperature at the State Meteorological Stations during the Years 1859-1872."—Herr Smitt gave an account of a visit paid by Herr P. Olsson, assisted by a grant from the Academy, to Norrland for zoological research.—Herr Th. M. Fries gave an account of two reports made to the Academy—one by Docent Berggren, who had gone to New Zealand for the purpose of studying its flora, and the other by Dr. Hellbom, who had made a lichenological visit to Norrland.—The following papers were communicated:—On the influence of inequalities with long period on the expression for the absolute perturbations of periodic comets, by Herr Gyldén.—Narrative of an expedition to Novaya Zemlya and the mouth of the Jenesei in 1875, with map, by Prof. Nordenskjöld.—On the simultaneous covariants of the fourth order and fourth class of two conic sections, by Prof. Bjorling.—On sulphonaphtholid, by Prof. Cleve.—On the action of pentachloride of phosphorus on β naphthol, by Prof. Cleve and Candidate Julin-Dannfelt.—On the estimation of nickel in nickeliferous magnetic pyrites, by Herr Ekelund.—Contributions to the knowledge of the development of Rajæ, by Intendent Malm.—Contributions to the Orthopter-fauna of South Africa, by Prof. Stål.

Paris

Academy of Sciences, May 29.—Vice-Admiral Paris in the chair.—The following papers were read:—On the atomic constitution of bodies, by M. de Saint-Venant. There is nothing contradictory in regarding atoms as material points having all the properties of visible and tangible bodies, less extension.—New remarks on the real existence of a matter formed of isolated atoms comparable to material points, by M. Berthelot. He gives reasons for withholding assent to MM. Kundt and Warburg's view.—On the salts formed by peroxide of manganese, by M. Frémy.—Observations on a basking shark recently caught at Concarneau, by MM. Gervais. This species (*Squalus maximus*) is found but rarely in temperate waters. It has a number of flexible, elastic filaments (of osseous nature) attached to the branchiæ; these sift the water, retaining the small animals as food.—Examination of the possible mechanical action of light. Study of the radioscope of Mr. Crookes, by M. Ledieu. The author's theory (implying a special action of polarised light) was submitted to the test of experiment by M. Fizeau, but with negative results. Further experiments are promised.—The Caucasus and its mineral waters, by M. François.—Intensity of gravity in the island of St. Paul, by M. Cazin. The apparent acceleration of gravity there exceeds the theoretical acceleration by $\frac{1}{1000}$ of its value. May not this affect astronomical observations?—On the radiometer of Mr. Crookes, by M. de Fonvielle. He describes experiments, whence he infers an impulsive action of light. M. Fizeau says that if a bundle of solar rays fall on the instrument, limited by a screen so that they strike only the polished surfaces, the rotation is such that each vane comes to meet the rays instead of escaping from them, as would be the case if the light had impulsive force.—On the Phylloxeras of the leaves of the French vine, by M. Delachanal.—On the laws of matter, by M. de Marsilly.—On a compressed air filter for water, by MM. Chanoit and Midoz.—On the transformation of elliptic functions, by M. Laguerre.—On the development in series of the functions Al(x), by M. Joubert.—On the charge taken by the disc of the electrophorus, by M. Douliot. He describes an arrangement by which he verified the theoretical conclusion that the charge of the disc is proportioned to its radius.—Theory of spectra; observations on Mr. Lockyer's last communication, by M. Lecoq de Boisbaudran. All spectral lines change in relative intensity when the temperature is raised; Mr. Lockyer's theory would imply that each element is decomposed into as many more simple substances as its spectrum has lines. Considering the immense number of lines in certain spectra, such a view seems little probable.—On the constitution of prophylenic monochlorhydrines, and the law of addition of hypochlorous acid, by M. Henry.—On a quinoacetate of calcium, by M. Gundelach.—Variations of the electric state of the muscles in voluntary contraction and artificial tetanus, studied with the aid of the galvanoscopic limb, by MM. Morat and Toussaint.—Anaesthesia by the method of intravenous injections of chloral; amputation of the thigh; absolute insensibility; consecutive sleep for six hours; cure without any accident; by M. Oré.—On frauds met with in the points of lightning conductors, by M. Francisque Michel.

CONTENTS

THURSDAY, JUNE 22, 1876

WALLACE'S GEOGRAPHICAL DISTRIBUTION OF ANIMALS

The Geographical Distribution of Animals, with a Study of the Living and Extinct Faunas, as Elucidating the Past Changes of the Earth's Surface. By Alfred Russel Wallace. Two Vols. 8vo. (London: Macmillan and Co., 1876.)

THE question of the number and boundaries of the primary zoological regions of the Globe has recently been discussed by Prof. Newton in his article on "Birds," in the new edition of the "Encyclopædia Britannica." After remarks on the failure of previous writers to solve this problem in a satisfactory manner, Prof. Newton comes to the conclusion that the outlines of distribution laid down in 1857 by Mr. Sclater, although founded only upon the study of the erratic class of birds, have "not merely in the main, but to a very great extent in detail, met with the approval of nearly all those zoologists who have since studied the subject in its bearing upon the particular classes in the knowledge of which they themselves stand pre-eminent." In point of fact, Mr. Wallace himself was one of the first naturalists to accept Mr. Sclater's views on this subject. Writing from the remote island of Batchian, in the Indian Archipelago, in March 1859, after perusing Mr. Sclater's well-known memoir on the Geographical Distribution of Birds,[1] Mr. Wallace says, in a letter to Mr. Sclater published in the first volume of the *Ibis*,[2] "With your division of the earth into six grand zoological provinces I perfectly agree, and I believe they will be confirmed by every other department of zoology as well as by botany." In the two excellent volumes now before us, in which are embodied the results of several years continuous labour upon this and kindred branches of the same subject, it will be seen that Mr. Wallace has not altered his opinion. The six great primary zoological regions of the Globe proposed by Mr. Sclater in 1857 are fully adopted, and form the basis of Mr. Wallace's whole treatment of the subject. But one slight change even in their nomenclature is made—that of substituting "Oriental" as the name of the Region embracing South Asia and the adjacent islands for Mr. Sclater's term "Indian." In fact, after discussing the general principles and phenomena of distribution and what little we as yet know concerning the distribution of extinct animals, the main portion of Mr. Wallace's volumes is occupied by an elaborate sermon on Mr. Sclater's text, and on its application to other classes of animals. The various phenomena of life exhibited in the Palæarctic, Ethiopian, Oriental, Australian, Neotropical, and Nearctic regions are treated of in succession, and their similarities and their differences are discussed. To this is added a sketch of the geographical distribution of the principal families of terrestrial animals arranged systematically, which forms the fourth part of this important work. Of this last portion, which is, in fact, a book of reference containing an account of the distribution of all the families, and of most of the genera of the higher animals arranged in systematic order, we propose to speak in a subsequent article. For the present we will confine our attention to the first three parts of Mr. Wallace's work.

The introductory chapter, with which the first volume of the "Geographical Distribution of Animals" is commenced, although it states the object of the work plainly enough to the mind of the scientific reader, seems a little too brief and concise to explain the nature of the problem under discussion to the general public. It must be borne in mind that the very idea of the existence of any regular laws of distribution is a novelty to most people—even, we regret to say, to many who call themselves naturalists. It is to be regretted, therefore, we think, that Mr. Wallace has not devoted a few more pages to the general explanation of the subject of which he treats, to the pointing out of the many subordinate problems which it involves, and in particular to the further explanation and definition of such technical terms as "*habitat*," "stations," "range," and "representative species," which confront us in some of the very first pages of his work.

In his second chapter Mr. Wallace discusses the means by which animals are dispersed, and devotes a good deal of space to the question of migration. Now, migration is, no doubt a very important phenomenon, but whether it has much to do with the general theory of distribution appears to be rather doubtful. It occurs only in one or two groups of animals; and, as Mr. Wallace himself observes, "we must, except in special cases, consider the true range of a species to comprise all the area which it occupies regularly for any part of the year." Migration, therefore, primarily affects the distribution of a species within its own specific area, and only has to do with the general question of distribution so far as it may increase the tendency of a species to vary its range. With Mr. Wallace's views on the subject of dispersal generally we cordially agree. There can be no question that, in the "glacial epoch" and in the more recent geological changes which have taken place on the earth's surface, the key of the present complicated phenomena of distribution should be sought, although many of them have had a much earlier origin. "Almost every mile of land-surface has been again and again depressed beneath the ocean; most of the great mountain chains have either originated or greatly increased in height during the Tertiary period; marvellous alterations of climate and vegetation have taken place over half the land-surface of the earth; and all these vast changes have influenced a globe so cut up by seas and oceans, by deserts and snow-clad mountains, that in many of its more isolated land-masses, ancient forms of life have been preserved, which, in the more extensive and more varied continents have long given way to higher types."

Mr. Wallace now proceeds to enter upon the grand question of Zoological Regions, entirely ignored, as he truly says, by the older school of naturalists. To them, provided they got the object, it little mattered whence it came. "The Brazils," the "East Indies," or the "South-sea Islands," was considered *ample* information as to the locality of any specimen, even if it were thought necessary to give such information at all. How could such men appreciate the idea of Zoological Regions? They

[1] See "Journal of the Proceedings of the Linnean Society," Zoology, ii. p. 130.

[2] Letter from Mr. Wallace concerning the Geographical Distribution of Birds. (*Ibis*, 1859, pp. 449.)

had a sort of vague notion that certain forms were peculiar to hot climates, and that certain others were only found in cold countries, but that was about all they knew or cared to know. Of the necessity of precise knowledge on the subject of locality they were absolutely incredulous.

"To the modern naturalist, on the other and," as Mr. Wallace most truly observes, "the native country (or 'habitat' as it is technically termed) of an animal, or a group of animals, is a matter of the first importance; and as regards the general history of life upon the globe, may be considered to be one of its essential characters. The structure, affinities, and habits of a species, now form only a part of its natural history.

"We require also to know its exact range at the present day and in prehistoric times, and to have some

FIG. 1.—Forest in Borneo.

knowledge of its geological age, the place of its earliest appearance on the globe, and of the various extinct forms most nearly allied to it. To those who accept the theory of development as worked out by Mr. Darwin, and the views as to the general permanence and immense antiquity of the great continents and oceans so ably developed by Sir Charles Lyell, it ceases to be a matter of surprise that the tropics of Africa, Asia, and America should differ in their productions, but rather that they should have anything in common. Their similarity, not their diversity, is the fact that most frequently puzzles us."

Yet, in spite of the increased attention paid to locality by Swainson, Waterhouse, Strickland and all the more

highly educated class of naturalists within the last fifty years, it was not until 1857 that the plan of determining the great zoological regions of the earth's surface not from *à priori* reasons of heat and cold, nor from the ordinary views of geographers, but by the minute study of the actual ranges of the more important and best known groups of animals was suggested. Mr. Sclater's Regions, then originally established from consideration of the ranges of the principal families and genera of birds, were quickly applied by Dr. Günther to reptiles and batrachians, and subsequently by Mr. Sclater himself to mammals. Working from the same stand-point, various naturalists have of late years tried to improve upon them, amongst others Mr. Blanford, Mr. Blyth, and

FIG. 2.—Scene in New Guinea.

Prof. Huxley. Mr. Wallace will have none of these—nay, so convinced is he of the correctness of Mr. Sclater's original "happy thoughts"—that he will not even listen to the inventor's own emendations of his original regions. "So that we do not violate any clear affinities"—he observes, "or produce any glaring irregularities, it is a positive, and by no means an unimportant advantage to have our named regions approximately equal in size, and with easily defined and easily remembered boundaries."

He therefore condemns "all elaborate definitions of inter-penetrating frontiers" and "regions extending over three-fourths of the land-surface of the globe" as "most inconvenient—even if there were not such differences of opinion about them." He admits that the "most radical

zoological division of the earth" is made by "separating the Australian regions from the rest," and that the best natural division of the remainder is effected by cutting off the Neotropical region. We should then have three primary zoological regions, which first Prof. Huxley, and afterwards Mr. Sclater, in his oral lectures on geographical distribution seemed to consider as of nearly equal importance. On this Mr. Wallace remarks that "in isolation and speciality, determined by what they want, as well as by what they possess, the Australian and Neotropical regions are undoubtedly each comparable with the rest of the earth. But in richness and variety of forms they are both very much inferior, and are much more nearly comparable with the separate regions which compose it." After discussing this subject at some length, and disposing shortly of Mr. Allen's system of "circumpolar zones," Mr. Wallace comes to the conclusion that a consideration of all the facts zoological and palæontological, indicates that the great northern division, or *Arctogæa*, is as much more important than either Australia or South America, as its four component parts are less important. He therefore reverts to the six original regions proposed by Mr. Sclater in 1857, as the most workable, and most conveniently adapted for the study of zoological distribution.

Thus much having been settled, Mr. Wallace proceeds to point out the limits of the six great regions, and to indicate the sub-regions into which they may be best divided. As regards the latter part of this task there is much difficulty. It must be confessed that the sub-regions in many cases are as yet only approximately determined, and that those adopted by Mr. Wallace are in several instances open to serious question. For example, "the great central mass of South America, from Venezuela to Paraguay" is constituted in the present work as a single division of the Neotropical region under the name of the "Brazilian Sub-region." But there can be no doubt that within this area there are two, if not three, distinct sub-regions which deserve recognition. The fauna of south-eastern Brazil, so admirably investigated by Prince Max. of Neuweid, Burmeister, Reinhardt, and other well-known naturalists, is very distinct from that of the great Amazonian valley, and the adjacent flats of Guiana and the Orinoco. Many genera are peculiar to each of them, and a whole host of representative species perform similar functions within the respective areas. Herr von Pelzeln's divisions of the Neotropical region, and those employed by Messrs. Sclater and Salvin in their papers published in the Zoological Society's *Proceedings*, are much more natural than those suggested by Mr. Wallace. We fear that in spite of what he says on the subject our author has rather allowed a hankering after uniformity to lead him astray and to induce him to restrict his sub-regions to four in each case.

The chapter on Classification which next follows, and concludes the first portion of the work, contains some very apposite remarks. A natural classification of animals is, as Mr. Wallace observes, of first-rate importance in discussing matters of distribution. But, except in the case of a few groups, we have by no means yet attained to a natural classification of animals, and even as regards these we are, in the opinion of many naturalists, still very [illegible] only therefore some few of the classes of animals that are sufficiently known to be useful for the study of distribution. As such Mr. Wallace selects the Vertebrata, the butterflies, and six families of Coleoptera amongst the insects, and the terrestrial and fresh-water land-shells amongst the Mollusca. Of these better-known groups he gives us tables of the arrangement which he proposes to adopt for the illustration of his remarks on their geographical distribution.

(*To be continued.*)

OUR BOOK SHELF

Notes on Collecting and Preserving Natural History Objects. By J. E. Taylor, E. F. Elwin, Thos. Southwell, Dr. Knaggs, E. C. Rye, J. B. Bridgman, Prof. Ralph Tate, Jas. Britten, Prof. Buckman, Dr. Braithwaite, Worthington G. Smith, Rev. Jas. Crombie, W. H. Grattann. Edited by J. E. Taylor, Ph.D., F.L.S., F.G.S., &c. (London: Hardwicke and Bogue, 1876.)

THIS is a republication of a series of papers from *Science Gossip;* and the names of the respective authors is a sufficient guarantee for the value and accuracy of the information it affords. It is a very useful book to put into the hands of young persons with some taste for natural history but quite ignorant of how to collect and what to observe; since it devotes as much space to the latter branch as to the former, and is thus a more instructive work than its title indicates. The subjects discussed are—geological specimens, bones, birds' eggs, lepidoptera, beetles, hymenoptera, land and fresh-water shells, flowering plants, grasses, mosses, fungi, lichens, and seaweeds. It is a pity that a few other essays were not obtained—on birds, mammals, reptiles, fresh-water fishes, crustacea, spiders, and sea-shells—so as to make the book somewhat more complete as regards "Natural History Objects;" but so far as it goes it is an excellent little work, and is perhaps better adapted to encourage an incipient taste for the study of nature than many more pretentious volumes. The chapters on birds' eggs, butterflies, and beetles, are especially full and interesting; while those on bones and fungi are valuable, as likely to incite the reader to take up the study of these somewhat neglected objects.

A. R. W.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Harris Cubit of Karnak

As the measures of this cubit hitherto published are more or less incomplete, the following series may be worth attention.

For permission to examine this relic, I am indebted to Dr. Birch, under whose care it is placed in the British Museum; and who, with his usual courtesy, gave every facility for its measurement.

The readings were taken by laying this wooden cubit on a brass standard scale, divided to tenths of an inch and to millimetres, with its divided face at right angles to that of the scale. Two observers then read the values of the divisions in both inches and metres, giving four readings in all, at about 66° F. The standard scale has since been kindly verified by Mr. H. W. Chisholm, Warden of the Standards, and its error is not of such an amount as to affect the figures here given; it is now in the Loan Collection of Scientific Apparatus (200), the sole representative at South Kensington of Kater's standards.

The readings were mapped on divided paper, and the mean result for each line carefully estimated, with its probable error, by the two observers: and though the following readings of the divisions are of course far from the limit of attainable accuracy, yet as their errors are but a small fraction of those of the gradua-

tions of the cubit, farther accuracy would be nearly useless, especially in view of the width and deficient symmetry of the dividing lines.

The zero point of the series is adjusted so as to fit the normal scale of equal spaces deduced from it, with equal errors + and —, on the series of palms.

	British Inches. Cubit Divisions.	British Inches. Normal Scale.
End of rod	—·026	·000
Palms	2·952	2·956
	5·911	5·913
	8·873	8·869
	11·820	11·826
	14·779	14·785
	17·735	17·739
	20·702	20·695
	23·665	23·652
	26·605	26·608
	29·582	29·565
	32·516	32·521
	35·481	35·477
Digit	36·195	36·217
Condyle	36·922	36·956
Digit	37·694	37·695
Palm	38·417	38·434
Condyle	39·910	39·912
End of rod	41·402	41·390

The average probable error of these determinations of each line (omitting the ends) is ·0008 inch, so that it may be called 1 on the last place of figures here given.

The total length of the rod is 41·428 with a probable error of ± ·0025. Sir Gardner Wilkinson (and Queipo from him?) states it as 41·30; John Taylor, 41·46; and Col. Sir Henry James, 41·398. Thus the above determination falls between these three authorities, and is in fact about reached by the probable error of the mean of them.

Besides the total length of the rod, the divisions must be considered as giving a value for the cubit. Leaving, therefore, for separate consideration the lesser subdivisions and ends, we will look only to the series of palms. As these were probably copied mechanically from another standard, and were apparently not produced by stepping lengths on the rod, we should ascertain the mean value they give for a Normal scale, and their errors from it. This carefully computed from these palm divisions is 41·390 for the cubit, or 2·956 for each palm; and the average error of the palm divisions is ·007 (the maximum error is ·018), so the probable error of this value for the mean cubit is about ·002. This average error of $\frac{1}{140}$ inch is rather large, but not worse than would probably be made at the present time in such work. By having a standard scale for comparison, hand dividing may be done on a still longer rod with a quarter of the error of this cubit, or even less; but as a mason's measure, this cubit is at least as accurate as modern examples.

The digit divisions are remarkable; the two last fit the Normal scale as accurately as the palms, but in making the divisions 36·195 and 36·922, the scale has apparently slipped away from that end of the rod about ·028; and thus these have an average — error of that amount. The ends appear to have been left rather long, perhaps to allow for wear, being ·026 and ·011 too long respectively, giving an average surplus of ·019. This may be intentional, or may result from being copied from a longer standard than the subdivided prototype, or may be merely an error. In any case, the tolerable equality of the surplus at each end, seems to show that the subdividing was from another standard, and not by stepping successive distances, as the difference is only $\frac{1}{3000}$ of the total length.

In Queipo's Metrology the value of each palm of this example of the cubit is stated to the millionth of a metre, two places farther than really measured, as they are merely reduced from English inches and hundredths, with an occasional half-hundredth. These values are all about $\frac{1}{300}$ too short (their sum being 41·3, as Sir Gardner Wilkinson's statement), but otherwise they agree closely with the series given above; and their mean difference from it (when corrected for their general shortness) is ·011, or but little more than the hundredth of an inch to which they were originally read.

If from the other eight or nine examples of the Karnak cubit the mean cubit was deduced from the subdivisions, and the internal errors of it thus obtained, we should have more knowledge of the accuracy of the earliest known civilisation, a datum of much interest from a scientific and historical point of view. A similar examination of the measures of classical and mediæval times, including our ancient national standards of all kinds, would also give an idea of the accuracy which in various ages, and for various purposes, has been considered to be the utmost requisite; a maximum datum very different to that obtainable from other remains, which only show the amount of accuracy usually employed. As a chapter of the history of science, now so much considered, this subject should not be longer neglected.

Bromley, Kent W. M. FLINDERS PETRIE

The Chemical Society

THE article which appears in NATURE, vol. xiv. p. 125, on the Organisation of the Profession of Chemistry throws doubt on the expediency of effecting the proposed organisation through the instrumentality of a society which has solely occupied itself with the extension and diffusion of knowledge, viz., the Chemical Society. It farther proposes that as it would be a wide departure from the functions which the Chemical Society has hitherto performed to undertake the appointment of a Board of Examiners, the Universities of Oxford, Cambridge, and London should be asked to co-operate in the matter, being already formed examining bodies, which would probably command and deserve greater confidence than a board nominated by a newly formed Institute, or even by the Chemical Society.

On these remarks I beg to offer the following comments:—

1. The Chemical Society never has promoted the acquisition of such knowledge and skill as are necessary for the discharge of such duties as a professional chemist is required to undertake.

2. If the Chemical Society has performed all other functions but this—the fact is no argument against it appointing a Board of Examiners, or of conferring some distinction on those who are capable of acting in the service of the public as chemists; indeed, if this may conduce to the "general advancement of chemical science," the Society, by not taking such steps, is scarcely fulfilling the duties for which it was originally founded, and by opposing any such scheme it may actually retard the progress of chemistry in this country.

3. The writer of the article is apparently unaware of the fact that it would be very difficult to make any examination answer the purpose of testing a man's skill and technical as well as scientific knowledge in a satisfactory manner. An organisation scheme has been designed by a few gentlemen in conjunction with myself, so as to obviate examination as far as possible, or, in other words, to extend the examination over a period of six years. Those of us who are teachers in medical schools, and particularly those who at times have had to take to "coaching" for a livelihood, see the defects of a system which entirely depends upon examination as a test of qualification. Certainly no University examination would have the confidence of professional chemists. There are many business details besides granting certificates of competency which an organisation of chemists would be obliged to undertake, as, for instance, imposing such observances on the members as would tend to suppress objectionable practices which are somewhat too common at the present time.

The *Chemical News* for June 9 contains a sketch of an organisation scheme, and the conditions of admission for original members are there set forth. If the Chemical Society as a body agrees to accept such a scheme, by all means let it do so, but it does not appear clear whether the qualified Fellows of the Society could constitute a separate body, managing their own affairs, within the Society, without the interference of other Fellows not of the same class.

British chemists are now in request all over the world, Japan, India, China, Canada, and California, and some mark of distinction as "chemists" which those who go abroad might carry with them would be valuable to them and enhance the value of the science in this country. WALTER NOEL HARTLEY

Scientific Club, 7, Saville Row, W.

Lectures on Meteorology

IN these days of the rapid development of the standard sciences, and the multiplication of their offshoots into considerable sections nearly as big as their originators, it may not be inappropriate to represent the claims of meteorology for a separate existence apart from others. As geology and mineralogy have been developed out of the natural history of former times, so it may obviously be suggested that meteorology might be detached from natural philosophy with which it has been

hitherto connected, and be taught as a separate science on its own merits and usefulness, and extent of practical application. It is therefore proposed that meteorology might constitute a separate course of lectures, theoretical and practical, at our colleges, where might be expounded its bearings on navigation, agriculture, human health, and engineering. To it might also be attached the sciences of ventilation of buildings, as barracks, factories, and mines, and hydrology, or a knowledge of ocean and sea currents, and ice drifts.

The foundations for such a professorship in scientific materials have, it is suggested, now reached a sufficient weight and bulk as to furnish ample occupation, and to be of universal interest and general application.

Weather observatories, now numerously established, will require superintendents and assistants, captains of ships would be benefited by some scientific knowledge of the winds and waves, and farmers would find meteorology useful for the successful tillage of the soil.

Again, overseers of mines would derive some good from a knowledge of the mechanism of the currents of the air they have to regulate in ventilation, and engineers of waterworks would require to know the variability and extent of rainfall for the sites and construction of their reservoirs.

Finally, the science of the weather is of most importance of all to those who have to fulfil the duties of health officers in our great towns, and climatology is more than ever studied by the physician having to give advice to the numerous invalids who now travel abroad for the sake of restoration of health by change of air and scene.

In order to facilitate the accomplishment of this object, it is suggested that some means should be taken to originate a fund to defray the expenses of such a course of lectures, either in London or Edinburgh, both of which cities have meteorological societies which might lend their influence to promote such schemes of scientific development.

The class of men to whom resort might be suggested for patronage of this proposition would most likely be shipowners, landowners, and boards of health, either for the study of their self-interest or for the benefit of the public. SPES

Edinburgh, June

THE BRITISH ASSOCIATION—GLASGOW MEETING

THE arrangements for the reception of the British Association are fast progressing towards completion. The Executive Committee met on Tuesday, and the following is a brief sketch of the work which has been done:—

Finance Committee.—The total sum subscribed to the Guarantee Fund amounts to £6,559 10*s.*

Museum Committee.—This Committee has arranged as follows:—The Geological Exhibition will be accommodated in the Corporation Galleries, Zoology and Botany in the lower Queen's Rooms, and Archæology, &c., at the University. These exhibitions will be large and complete, and arrangements have been made for keeping them open, if desired, for some time after the meeting of the Association.

Local Industries Committee.—This Committee has three sub-committees—one for Machinery, one for Chemicals, and one for Textile Fabrics—and the materials for a highly instructive exhibition are being collected, which will be held in Kelvingrove Museum, where there is already a general museum of considerable size and variety.

Reception Committee.—Already a number of distinguished persons have been invited and have accepted invitations. Among these are the President-designate, Prof. Andrews, of Belfast, who will be the guest of Sir William Thomson, the present President, Sir John Hawkshaw, who, with Lieut. Cameron, the African explorer, will be the guest of the Lord Provost. The Duke of Argyll, one of the Vice-Presidents, will be the guest of Prof. Blackburn.

Arrangements have been made with all the leading railway companies in England and Scotland to facilitate the visits of strangers and their stay in Glasgow. A guide and handbook for Glasgow and the West of Scotland is being prepared under the general editorship of Dr. Blackie.

The following places have been secured for the use of the Association:—The University, where, as at present arranged, all the Sections except the Geographical and Ethnological Section (Section E) will meet, Section E meeting in the large upper hall of the Queen's Rooms. At the University, also will be the Reception and Refreshment Rooms. Kelvingrove Museum.—This will be the receptacle for the exhibitions of machinery, of chemicals, and textile fabrics. Queen's Rooms.—Here will be held an exhibition of the zoological and botanical collections of the district, and here also the meetings of Section E will take place. The upper Corporation Galleries will be filled with a geological exhibition, there being no room at the museum at the University to accommodate more than the Archæological Section, in addition to the permanent and temporary exhibits already arranged there. The City Hall and the Botanic Garden Palace have also been secured for the use of the Association. The Chambers of the Association, where all inquiries may be made, will be found at 135, Buchanan Street.

A great many of the citizens have indicated their wish to receive guests, and a list is being drawn up of expected visitors, from which guests may be selected. Notice of its completion will be given by advertisement in the newspapers.

Excursion Committee.—It has been arranged that excursions will take place on Saturday, the 9th, and Thursday, the 14th of September, to the following among other places: Arran, Lochlomond, Loch Fyne, and the Holy Loch, Coatbridge, and Paisley. Mr A. B. Stewart has placed his yacht at the disposal of the Association, as has also Mr. Duncan of Benmore, for dredging expeditions. It is intended that there will be at least one dredging excursion to the Firth of Clyde, or other suitable place. Mr. Duncan will also receive at Benmore a party of 100, who go the round by Loch Fyne, for whom he has arranged a delightful excursion. Mr. Martin of Auchendennan will receive a party at dinner there, and Mr. Campbell of Tullichewan and Mr. Matheson of Cordale have also intimated their desire to show hospitality to members of the Association visiting Dumbartonshire. Mr. Ellis will entertain a party at luncheon at Coatbridge after inspection of the North British Wireworks, and Sir Peter and Mr. Thomas Coates are expected to do the same at Paisley.

ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE[1]

II.

Experimentation with the forms of Lycoperdon giganteum, or common Puff-Ball.

IN 1853, while the study of the art of producing safe anæsthesia was fresh upon me, my attention was directed by my friend, Mr. H. Hudson, to the fact that in the country the owners of bees rob the bee-hive of its contents of honey and wax after they have stupefied the bees by driving into the hive the smoke of the common puff-ball—*lycoperdon giganteum.* It struck me at once that I ought to ascertain whether the stupefying agent which is given off in the smoke would act as an anæsthetic on the higher animals and on man, and whether a new and safer anæsthetic than chloroform was contained in it. The results of this research, some of which I published in the *Association Medical Journal* in 1853, showed that the narcotic agent present is indeed a true anæsthetic, and that all animals may be narcotised by it, but that owing to the mode in which it has to be administered, it cannot conveniently be applied to man. All the lower animals about to be subjected to operations of any kind, surgical

[1] Continued from p. 152.

or physiological, could, I found, be rendered insensible by this agent safely and inexpensively. I invented a room or chamber in which animals could be placed so as to be exposed to the anæsthetic, and I introduced the use of this method of anæsthesia. From time to time during the past twenty-five years, many necessary surgical operations have been painlessly performed on domestic animals under this anæsthesia, and almost all my own physiological experiments which would have been painful have been conducted under it without pain. Some other physiologists have followed me in this procedure, and have introduced the puff-ball narcotising box into their laboratories in order to save pain from experiment. In these ways the simple experimental research derived from the observation on the bees has proved doubly useful.

While these researches were first being pursued a friend of mine came to me in great distress because his splendid and favourite retriever dog had been bitten by a rabid dog and was now stricken with rabies. He asked me to destroy his dog in the kennel, as nobody dared to remove the animal. I carried out the request at once by simply closing the door of the kennel, covering it with a horse-cloth, and letting the clarified and condensed fumes from the burning lycoperdon pass into the kennel. The animal lapsed quickly into sleep and died without a struggle. I believe this was the first time in the history of science in which anæsthesia had been employed intentionally and systematically for the painless extinction of the life of the inferior animals. I shall show in a future note the singular importance of this application.

Research with Carbonic Oxide.

The observation that the smoke of the burning lycoperdon would produce anæsthesia in the higher animals led naturally to an inquiry after the agent that was at work in creating the insensibility. I commenced to make an analysis of the smoke in order to determine the question, but was forestalled in discovery by two other experimenters, the late Dr. John Snow,—so well known for his researches in anæsthetics, and as the author of the water theory of cholera,—and by the late Thornton Herepath, one of our most promising young chemists. These two gentlemen almost simultaneously discovered that the gas called carbonic oxide is present in the smoke of the lycoperdon. This was a new light, and led me to study the action of carbonic oxide on animal life. I found that this agent, a colourless and inodorous gas, produced insensibility in precisely the same way as the purified smoke of the puff-ball. I found that when the combustion of the puff-ball was made so perfect that no carbonic oxide was formed, there was no anæsthesia induced by the purified fumes, and so the fact was rendered clear that the special anæsthetic in the smoke is the gas in question. I estimated also the proportions of carbonic oxide that could be breathed in the atmosphere, and the effects of the gas in larger and smaller proportions on the lower animals and on myself.

Experimentation in Relation to Diabetes from Breathing Carbonic Oxide.

In conducting the observations on the action of carbonic oxide on living bodies, I was led to examine the animal secretions, and to my surprise I found that the renal secretion of an animal subjected to the gas yielded evidence of glucose or grape sugar. The fact was of such importance I was compelled to follow it up until I had quite established it, and had proved that by the inhaling of this active gas, a temporary attack of the disease known commonly as diabetes, which in the human subject is often fatal, could always be artificially induced in the dog. In a further experiment I found that the inhalation of common coal-gas diluted with air would produce the same condition, an effect caused by the carbonic oxide which is always present in coal-gas. The same has subsequently been observed in a human subject accidentally exposed to the gas. The ultimate value of these observations has yet to be proved. When I first published, in the *Medical Times and Gazette*, on March 22, 1862, the fact of the artificial production of diabetes by carbonic oxide, nine years after I had first observed it, it was looked upon rather as a curious than a practical demonstration. I have always felt that though it did not seem to offer any immediate practical result, it must some day be useful in throwing light on the origin, or at least on one origin of a fatal malady. Quite recently Dr. Pavy has published some valuable details on the production of diabetes by the same means, that is to say, by making animals inhale carbonic oxide, and he has been able to arrive at some clear ideas on the question of the chemical changes that are involved in the process. We may fully expect to receive from him further valuable information.

I wait a moment at this point to observe that the history of experimental research given in the last note illustrates forcibly the value of what may be called the accidental observations that are picked up in the course of experiment. Who ever would have dreamed that from a practice of stupefying bees in order to rob them of their honey, a practice which has been carried on by the vulgar for many centuries, would come the discovery that the higher animals, and even man himself, can be made to produce glucose, and that they may become afflicted with the symptoms which characterise a destructive disease from a simple perversion in the animal chemistry induced by the smoke of the burning puff-ball ?

Experimentation with Oxygen Gas.

The experiments with carbonic oxide led me to a series of experiments with oxygen gas. The late Sir Benjamin Brodie and Mr. Broughton, in their experiments on this same subject, had observed that when animals are placed in pure oxygen they die, with symptoms of sleep, as if they were narcotized, although the products of respiration are removed. Hence for many years oxygen gas, on which we depend for life, was believed to be a narcotic or sedative poison. In my experiments many new facts came out which modified this view. In the first place I found that some animals, such as frogs, will live in oxygen as readily as in common air ; that herbivorous animals will live in it if it be kept supplied to them in fresh current, but the carnivorous animals will not live in the pure gas for a long time without becoming drowsy and insensible and without undergoing changes of their blood, which are fatal to life owing to separation of the fibrine within the vessels. The most important observation, however, which I made on the subject of the effects of oxygen, is the following :—I found that a narcotic action of the oxygen is produced, however pure from the products of respiration the oxygen is maintained, whenever it is breathed over and over again by being passed backwards and forwards through the chamber in which the animals breathe it. Subjected three times to this passage through the chamber, though it be purified so fully from carbonic acid that it contains less of this gas than the common air, it fails to support the active life of all common animals excepting frogs. In a word, the oxygen assumes a negative condition in which it will not support living function. In a report on these researches, made to the British Association for the Advancement of Science, at the Oxford meeting in 1860, I defined this state as one in which no new poison was produced, but in which the oxygen lost some principle or property by which in its fresh state it sustained the animal life.

The lessons taught by these observations extend to the human family. They show that if the oxygen of the great atmospheric sea in which we all breathe should from any cause assume this negative condition, it will fail to sustain the active life. They explain the depressing effect of breathing over again the same air in close and badly ventilated rooms. They throw a distinct light on that "epidemic condition" of the atmosphere, which, since

the time of Sydenham has been noticed, but never explained, in which diseases of spreading type extend uncontrolled when once they are started on their course. In the artificial negative atmosphere which I produced in the manner described above, I observed that dead animal and vegetable substances underwent rapid decomposition, and that slight wounds on living bodies became fœtid.

There followed upon these observations other series, in which the effect of the forces of heat and electricity were tried in order to determine whether they would modify the condition of the negative oxygen in respect to its life-sustaining power. The result of these inquiries was to prove that cold added to the negative effect and quickened the narcotism, while a raised temperature, a temperature of 75° F., delayed the narcotism. I also discovered that the passage of electrical sparks through the negative gas restored it to its full activity.

In yet another series of inquiries oxygen, under the influence of the forces of heat and electricity, was rendered active until its sustaining power was destroyed by an opposite process, viz., by the activity with which it entered into combination with the blood. In this manner the action of ozone was observed on animal bodies, and the quickened state of the circulation and over-action which the oxygen in this active state produces were defined. The local action of ozonized air on the air-passages and nostrils in the human subject was tested on Dr. Wood and myself, and the peculiar catarrh and headache which follow the inhalation of ozonized air were described from our own personal experiences.

The whole of these inquiries on the effects of differing physical conditions of oxygen were full of the most useful practical information in reference, it not actually to disease, to the mode in which surrounding atmospheric conditions modify the course of disease. They indicated how men and animals living in the large atmospheric sea are influenced by the action of the great forces of nature on the vital oxygen. They have taught me so much that I could, if I had the means, build a hospital with such appliances for modifying the air, that the course of some diseases might be governed towards recovery by the simple management of the physical conditions of the atmospheric oxygen. In a future and more advanced day of science, this method, the basic principles of which are here sketched out, will be an approved and positive method of treatment. Even now, under the greatest disadvantages, from want of organised plans, I have been able to render useful service to the sick from the experience gained by the experimentation.

BENJAMIN W. RICHARDSON

(*To be continued.*)

THE CRUELTY TO ANIMALS BILL

IN the House of Lords the Government "Vivisection Bill" was discussed in a full Committee on Tuesday. The Marquis of Lansdowne began by a very temperate remonstrance against the Government going so far beyond the recommendations of the Royal Commission on the subject. His speech (which is fairly reported in the *Times*) is by far the best for knowledge and for sense that has yet been made on the Bill, but the provision against which he especially protested—the licensing of places as well as of persons—though warmly supported by Lord Kimberley, still remains part of the Bill. This provision scarcely affects physiologists as such, but may be a means of serious annoyance and hindrance to strictly medical experiments, on, for instance, the contagion of disease or the action of drugs, and would have made the experiments by which Jenner freed the world from the plague of small-pox impossible.

On the first clause Lord Carnarvon stated that the title will be altered from "An Act to Prevent Cruel Experiments upon Animals" to "An Act to Amend the Law relating to Cruelty to Animals," *i.e.*, the Bill no longer pretends to prevent alleged cruelty by scientific men in this country, inasmuch as the charge has not been in a single instance maintained, and only provides that infliction of pain on an animal shall not be screened by the excuse of a scientific object, if the delinquent does not hold a certificate from the Secretary of State that he is a competent person to conduct experiments on animals with all possible humanity and with ability to make them useful.

After some desultory conversation on the definition of the word "animal" (in which one Minister of the Crown committed himself to the opinion that some creatures can feel when their heads are off), the first important amendment was moved by Lord Rayleigh, supported by Lord Cardwell, and accepted, after discussion, by the Ministry. The Bill now, therefore, actually recognises the pursuit of knowledge as equally worthy of respect with that of medicine, and both as entitled to some small share of the immunity accorded to the pursuit of wealth or of amusement. In other words, while the members of the House of Lords have all their lives been vivisecting their animals without anæsthetics *for fun*, they are now pleased to allow physiologists to do the same under many limitations for the advancement of science. This admission was actually opposed by Lord Coleridge in a speech which was forensic and sentimental in the worst sense of the words.

In the fifth clause, exempting cats and dogs from all experiments (even when painless) if undertaken for physiological or medical purposes, the Government accepted the amendment of the Earl of Harrowby, to include horses, asses, and mules under the same provision; but admitted a proviso for these animals being available on special certificate from the Secretary of State when absolutely necessary for some special investigation. On this clause the Earl of Airlie made a sensible speech, but he was not supported by the peers on the Royal Commission, whose report was implicitly condemned. The other clauses were rapidly run through, the Earl of Portsmouth making a successful attempt to obtain some recognition of the necessity of studying the diseases of animals as well as of man. The absurd regulation which, apparently by an oversight, subjected registered and inspected laboratories to the police visitation intended to prevent experiments in unregistered places, was amended without discussion, and the Bill is now probably in the form in which it will be laid on the table of the House of Commons.

Some of its most glaring contradictions and absurdities have been remedied; and, if worked by a reasonable Home Secretary, competent inspectors, and physiologists as humane as the ten or twelve gentlemen who now possess laboratories in the three kingdoms, it will probably do good. But the whole discussion shows the folly of legislating to satisfy unreasoning clamour, and the hopelessness of Parliament dealing in detail with a subject of which almost all its members are profoundly ignorant.

The reasonable plan would have been to register laboratories, and give certificates to persons duly recommended; to inspect them carefully; to withdraw the licence on any abuse being proved; and then to extend "Martin's Act" so as to apply to all cruelty to animals whether domestic or wild, whether performed with a bad object or a good one, so long as the delinquent did not hold a certificate. This would have been in accordance with the recommendations of the Royal Commission would have given far less trouble to Home Secretaries and to physiologists, and would have been a more effectual provision against cruelty. But Parliament has nothing important to do, the Government are in want of popular applause, and very few have the patience or the candour to learn the true state of the case; so that we must be content to hope that the Bill will do less harm than was at first inevitable.

A MUSEUM FOR INDIA AND THE COLONIES

AT the meeting of the International Congress of Orientalists in London in 1874, Dr. Forbes Watson read a paper in which he described (see NATURE, vol. x. p. 421) the plan of an Indian Museum, Library, and Institute. This paper was afterwards published (see NATURE, vol. xi. p. 413). Dr. Watson has just published a pamphlet[1] in which the proposed India Museum and Institute has very naturally expanded into an Imperial Museum for India and the Colonies. What Dr. Watson proposes is that on the site of the old Fife House, on the Victoria Embankment, at the Thames end of the ... Northumberland Avenue, a large and suitable building should be erected, to consist of two divisions, one devoted to the interests and products of India, and the other to those of the various British Colonies. The library and collections which already exist in connection with India are acknowledged to be of great value and importance, and their location in an appropriate building in a central position would greatly increase their usefulness. The arrangement at South Kensington is of course only temporary. Now that Dr. Watson has proposed a plan for an institution which would do for the other colonies what the India Museum and Library attempt to do for India, one wonders why steps have not been taken long ago to supply what appears to be a real want. The subject has, however, engaged for years the attention of those who take an active interest in the Colonies, and several of the Colonies have gone so far as to vote money for the establishment of a Colonial Museum in London. Few people realise the importance of the Colonies to Britain; their extent, population, and the value of their commercial transactions are forcibly exhibited by Dr. Watson in his pamphlet, which we would recommend those to read who wish to have some idea of the value of the Colonies to the mother country. From a scientific point of view such an institution as is proposed would be of great interest and value. British Colonies are to be found everywhere over the surface of the globe, and embrace all climates and every variety of natural productions. Students of natural science would find a properly arranged collection of our colonial productions of great use, especially if combined with a proper library, and no better method could be devised of educating the public generally as to the extent, importance, physical condition, and natural products of "Greater Britain."

Dr. Watson shows that from every point of view, political, commercial, and scientific, the establishment of such an all-embracing Imperial Institute would be of the greatest benefit both to this country and her Colonies, and would no doubt serve to bind them more closely together. We are sure his scheme needs only to be known in its details to recommend itself to the public, and we are confident that if steps were taken to move the proper quarter, the accomplishment of the scheme would be only a question of time. The Colonies themselves are willing to bear a share of the expense necessary, and it would only be fair that this country, through the Government, should meet the Colonists as far as it can.

Into the details of Dr. Watson's plan we have not space to enter. There would, as we have said, be virtually two museums under one building. In the division devoted to the extra-India Colonies, the museum representative of each Colony would be kept distinct, so that the whole would be rather a federation of museums than one museum. Then there would be a Colonial Library and Reading-room; provision would be made for giving a home in the Institution to the Asiatic Society and the Colonial Institute; by means of "Trade Museums," a full representation would be given of Colonial produce, and in the proposed institution the offices of the various Colonial agents now dispersed over London could be established. The advantages of such an Institution are well summed up by Dr. Watson in the following paragraph:—

"The combined India and Colonial Museums, established according to the above plan, would in every way become a living institution worthily representing the past history and the present resources of the British Empire throughout the world. Such an institution would afford not only exhaustive materials for study and research, but would likewise be suitable for reference by the Indian and Colonial authorities, by men of business or of letters, and by officials or emigrants intending to proceed to India or the Colonies. Thus it would be instrumental in furthering actual work or business, whether scientific, political, or commercial. At the same time, through its co-operation with the Asiatic Society and the Colonial Institute, through its reading-room, its lectures and publications, through the Trade Museums and other typical collections distributed all over the country, as well as throughout the most important places in India and the Colonies, all the information would be rendered available to the whole P . . ."

[1] "The Imperial Museum for India and the Colonies" By J. Forbes Watson, M.D., &c., Director of the India Museum. (Allen and Co.)

FERTILISATION OF FLOWERS BY INSE

XIV.

Flowers Fertilised by the Wings of Butterfl

IN my former articles many plants are referred to which are fertilised by butterflies, whose proboscis, head, legs, or whole underside comes into contact with the anthers and stigmas of the flow is visited; but hitherto no plant has been known which is fertilised by the fluttering wings of butterflies. My brother, Fritz Muller (Itajahy, Prov. St. Catharina, Brazil), has lately observed a species of *Hedychium* (Piperaceæ) whose bright red scentless flowers, opening in the morning, are wonderfully adapted to this manner of fertilisation. I give his description, as far as possible, in his own words.

The flowers of this Hedychium are collected in groups of 4–6, which are enveloped by a common bract; in every group only one flower is ever developed at the same time, this commonly fading before the next one has opened. The groups of flowers are arranged in alternating whorls, each consisting of three groups (Fig. 89); the spike thus formed reaches 0·25 metre in length, and is composed of six longitudinal rows of flowers, each row containin 8.

The corolla tubes, about 0·03 m. long, 0·5 and 1 mm. wide, are completely enclosed by the very firm common bract; moreover, each by its calyx closely embracing it, by its special bract and partly by the bracts of the older flowers of the same group. Thus the honey, which on the morning of the first day fills up about one-third, on the morning of the second day about two-thirds of the length of the tube, is excellently protected from being stolen by piercing the tube, of which some Apidæ, especially Hylocopa, are exceedingly fond. The flowers are placed nearly horizontally, the stamen a little above, the lip a little below a horizontal plain intersecting the entrance of the honey-tube. The lip, which in other species of Hedychium is expanded level and almost sessile, is here long stalked, and rolled up into a channel of 0·01 m. in length provided with a funnel-shaped entrance. The entrance of the lip-channel (Fig. 89 *A*) being about equally distant from the two longitudinal rows of anthers and stigmas Fig. 89 (*B*, *C*) between which it is situated, both rows are alike struck by the wings of the butterflies flying on and off.

The filament is 47 mm. long on the forenoon of the first day and somewhat bent upwards, so that the pollen-covered side of the anther looks outwards or even a little

[1] Continued from vol. xiii. p 294.

upwards (hence the stigma looks upwards or even obliquely backwards); on the morning of the second day it is 50 mm. long, straight, and the stigma looking forwards; by the morning of the third day the flowers bend aside and wither. Consequently on the first day the anthers, on the second day the stigmas are more liable to be struck by the wings of the butterflies, although the stigmas seem to be capable of being pollinated already during the opening of the flower. The pistil, as in other species of Hedychium, is inclosed in a completely closed channel of the corolla tube (Fig. 90) and of the filament (Fig. 91); the funnel-shaped stigma (Fig. 92), secreting plenty of fluid and bordered with hairs (Fig. 93), slightly overtops the anther (Fig. 89, *st.*).

By the morning of the second day all bees and butterflies with a proboscis of more than 10 mm. long would be enabled to obtain at least a little portion of the very sweet honey from out the opening of the corolla-tube; whereas from the more conveniently situated opening of the lip-tube the full store of honey can be reached only by a single species of the butterflies of Itajahy (as far as their proboscides have been measured by my brother), namely, the males of *Callidryas Philea*, with a proboscis from 36 to 43 mm. long.[1]

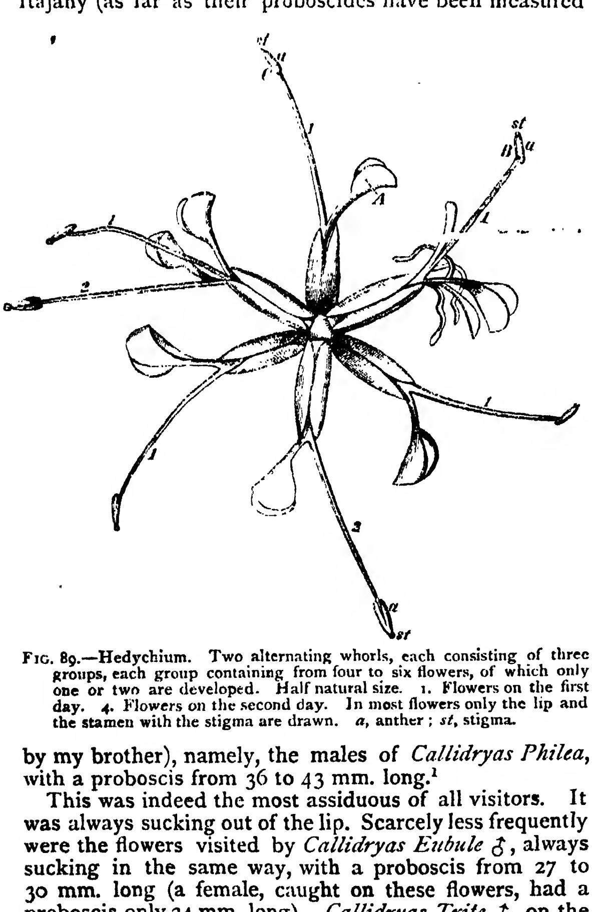


FIG. 89.—Hedychium. Two alternating whorls, each consisting of three groups, each group containing from four to six flowers, of which only one or two are developed. Half natural size. 1. Flowers on the first day. 4. Flowers on the second day. In most flowers only the lip and the stamen with the stigma are drawn. *a*, anther; *st*, stigma.

This was indeed the most assiduous of all visitors. It was always sucking out of the lip. Scarcely less frequently were the flowers visited by *Callidryas Eubule* ♂, always sucking in the same way, with a proboscis from 27 to 30 mm. long (a female, caught on these flowers, had a proboscis only 24 mm. long). *Callidryas Trite* ♂, on the contrary, with a proboscis 18 to 20 mm. long, seems always to suck immediately out of the corolla-tube. *Callidryas Statira* ♂ (19 to 21 mm.) mostly sucks in the same way; but sometimes also from out the lip. *Callidryas Argante* being very rare during the flowering time of this Hedychium (towards the end of January) was only occasionally seen visiting its flowers, and it was not observed in what way it reached the honey. Dark yellow, orange, scarlet, red, are the favourite colours, not only of the Callidryas but likewise of the *Agraulis* (*Dione*) and of some species of *Papilio*; of the former, *Agraulis vanillæ* (proboscis 15 mm.) visited the flowers several times, but soon flew away again. Of species of Papilio, *P. Thoas* (26 mm.) appeared especially frequently, as also several times *P. Palydamas* (24-25 mm.), *P. Cleotas* 22-23 mm.) three times, and once *P. Protodamas* (?) (22 mm.); these mostly fluttered upwards along the rows of flowers without settling down; it was not distinctly seen from which opening they obtained the honey.

[1] The proboscis of the female seems to be not so long; in two females measured by my brother it did not exceed 35 mm.

Another adaptation of the flowers to cross-fertilisation by butterflies must be mentioned. A wing of a butterfly is a tolerably smooth plain, moving rapidly when flying; the pollen-grains of Hedychium are likewise smooth; these peculiarities are ill adapted to each other; but this inconvenience is removed by the anthers not bursting, but their anterior-surface dissolving into a layer of slime which covers the pollen-grains and glues them to the wings.

Of Apidæ my brother once saw *Xylocopa*; it attempted to suck from the lip, but after having made some fruitless trials flew away again. He repeatedly met with *Bombus violaceus* and *Cayennensis*, rarely, however, compared with their frequent visits to other flowers, for instance, the neighbouring bushes of Buddleia. They sucked from out the corolla tube. *B. violaceus* was several times observed to alight on the lower flowers of a longitudinal row, climbing from there up the row more or less completely, then flying to another spike. In consequence of this systematic manner in which the most intelligent bees explore the flowers of a plant, the fertilisation by bees of a plant with such a number of flowers as our Hedychium

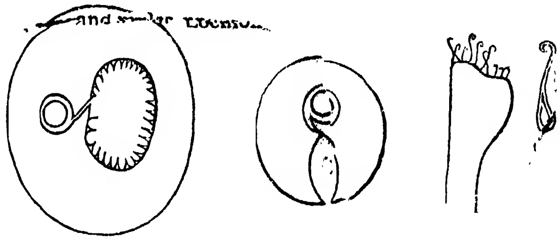


FIG. 90. FIG. 91. FIG. 92. FIG. 93.

FIG. 90.—Transverse section of the corolla-tube, 15 : 1. FIG. 91.—Transverse section of the filament enclosing the pistil. FIG. 92.—The stigma bordered with hairs. FIG. 93.—A single one of these hairs.

must be by far less advantageous than the fertilisation by butterflies. Suppose a specimen of this Hedychium bearing twenty spikes, each with fifty flowers, a humble-bee would be likely to visit 1,000 flowers without effecting a single cross-fertilisation between different plants, consequently without any profit for the plant, which is sterile with its own pollen. On the contrary, on flowers copiously visited by butterflies, the same butterfly will rarely visit a greater number of flowers of the same plant continuously; and this holds good, not solely, as Delpino has already remarked, with females which are followed by the males. On a Hedychium, males of Callidryas only were flying (females being then very rare), but, nevertheless, as soon as any butterfly was approached by another of the same or even of a different species, it flew up, ran and whirled with it about in the air, and then alighted commonly on another bush.

Lastly, there appeared repeatedly several species of humming-birds, one of which was so absorbed in sucking the honey that it could be caught with a net, which my brother had never before succeeded in doing. In the corolla-tube of this Hedychium small insects have never been found by my brother; the perseverance with which the humming-birds made use of its flowers proves, therefore, in case such a proof should still be needed, that these birds were here searching for honey.

It may be remarked in addition that humming-birds are far less exclusively attracted by the bright red colour of flowers than Callidryas; and, as these butterflies are

those which are found in greatest numbers in Itajahy (*Acræa Thalia* only perhaps equalling or even surpassing them in number), the frequent occurrence of orange-coloured or scarlet flowers in that country is probably less an adaptation to humming-birds than to this fondness of Callidryas The red Salvia, Canna, the orange-coloured species of Lantana, *Epidendron cinnabarinum*, &c, are assiduously visited by Callidryas.

Lippstadt, May 13 HERMANN MÜLLER

LOAN COLLECTION OF SCIENTIFIC APPARATUS

SECTION—MECHANICS

PRIME MOVERS[1]

WE now come to Newcomen, who I think may fairly be looked upon as the father of the steam engine in its present form No 1,942 is a model of his engine, which is further illustrated by a rare engraving (of 1712) the property of Mr Bennet Woodcroft

Here we have the steam boiler, the cylinder, the piston and rod, the beam working the pumps in the pit, the injection into the cylinder and the self acting gear, making altogether a powerful and an automatic prime mover

That conscientious writer, Belidor, to whom I have already frequently referred, says, that he learns of one of these machines having been set up in the water works on the banks of the Thames at York buildings I may say to those who are not aware of it, that these works were situated where the Charing Cross Station now stands On a Newcomen engine being erected in France at a colliery at Fresnes, near Condé, Belidor paid several visits to it in order that he might understand its construction thoroughly, and be thereby enabled to explain it to his readers. He has done so with a minuteness and faithfulness of detail, in description and in drawings, that would enable one to repeat the engine This engine had a 30 inch cylinder with a 6 feet stroke of the piston and of the pumps The boiler was 9 feet in diameter and 5½ feet deep in the body, it had a dome which was covered with masonry 2 feet 6 inches thick to hold it down against the pressure of the steam It had a safety valve (the Papin valve) which Belidor calls a "Ventouse," and says that its object was to give air to the boiler when the vapour was too strong It had double vertical gauge cocks the function of which Belidor explains, it made fifteen strokes in a minute, and he says that being once started it required no attention beyond keeping up the fire, that it worked continuously for forty eight hours, and in the forty eight hours unwatered the mine for the week, whereas previously to the erection of the engine the mine was drained by a horse power machine, working day and night throughout the whole week and demanding the labour of fifty horses and the attendance of twenty men to keep the water down I should have said that the pumps worked by the steam engine were 7 inches bore and were placed 24 feet apart vertically in the pit which was 276 feet deep, and that each pump delivered into a leaden cistern from which the pump above it drew.

After having given a most accurate description of the engine, Belidor breaks out into a rhapsody and says (I will give you a free translation) "It must be acknowledged that here we have the most marvellous of all machines, and that there is none other of which the mechanism has so close a relation to that of animals Heat is the principal of its movements, in its various tubes a circulation like that of the blood in the veins is set up, there are valves which open and shut, it feeds itself, and it performs all other functions which are necessary to enable it to exist"

Smeaton employed himself in perfecting and in properly proportioning the Newcomen engine, but it was not until James Watt that the next great step was made, that step was as we all know the doing away with condensation in the cylinder, the effecting it in a separate vessel and the exclusion of the atmosphere from the cylinder These alterations made a most important improvement in the efficiency of the engine in relation to the fuel consumed, but they were so simple that I doubt not if examiners into the merits of patents had existed in those days Mr Watt would have had his application for a patent rejected as being "frivolous" We have here from case No 1,926, a model made by Watt which appears to be that of the separate condenser and air-pump, we have also 8B which is a wooden model made by Watt of a single acting inverted engine having the top side of the cylinder always open to the condenser, and a pair of valves by which the bottom side of the piston can be put into alternate connection with the boiler and with the condenser, the contents of which are withdrawn by the air pump 9B from the same case is a model of a direct acting inverted pumping engine, made in accordance with the diagram 8B 11 is a model of Watt's single acting beam pumping engine, while 2B is a model of Watt's double acting beam rotary engine 101 from the same case is Watt's model of a surface condenser To Watt we owe, condensation in a separate vessel, exclusion of the air from the cylinder, making the engine double acting, employment of the steam jacket, and employment of the steam expansively, the parallel motion, the governor, and in fact all which made Newcomen's single acting reciprocating pumping engine into that machine of universal utility that the steam engine now is, and not only so, but Watt invented the steam engine indicator which enables us to ascertain that which is taking place within the cylinder and to see whether or not the steam is being economically employed I have on the table before me a very excellent model of German manufacture No 2,137, illustrating an inverted direct acting pumping engine in its complete form, and I have also a model of French manufacture, the cylinder and other working parts of which are in glass, this shows a form of Watt rotary beam condensing engine at one time in common use

I do not say, however, that Watt was the first to make the suggestion of attaining rotary motion from the power of steam Leaving out of consideration Hero's toy, Papin, as I have remarked, hoped to get rotary movement second hand by working a water wheel with the water that had been raised by his steam-engine, moreover, as early as 1737, Jonathan Hulls proposed to obtain rotary motion from a Newcomen engine and to employ that motion in turning a paddle wheel, to propel a tug boat which should tow ships out of harbour, or even against an adverse wind I have before me one of the prints of his pamphlet and in order that you may better appreciate his invention I have put an enlarged diagram upon the wall and I think I may take this as the starting point for saying a few words about the steam engine as a prime mover in steam vessels

We have in the collection, No 2,150 Symington's engine tried upon the lake at Dalswinton in 1788 Here a pair of single acting vertical cylinders give, by the up and down motion of their pistons, reciprocating movement to an overhead wheel, this wheel gives a similar motion to an endless chain which chain is led away so as to pass round two pairs of ratchet wheels loose upon two paddle shafts By the use of a pair of ratchets the reciprocations of the chain are converted into rotary motion in one direction only and that the driving direction of the two paddle wheels placed one behind the other Symington's arrangement for obtaining the rotary motion always in one direction of his two paddle wheels is very similar to that proposed by Jonathan Hulls for his single stern wheel Want of time forbids me to do more than just to allude to the names of Hornblower and Wolff in connection with double cylinder engines, engines where in the expansion of steam is commenced in one cylinder and continued in another and a larger one

I wish to say a few words which will bring before you the changes that have been made within a very few years in the construction of the marine engines I may observe that when I was an apprentice the ordinary working pressure of steam, except in the double cylinder engine, was only 3 lbs above atmosphere, and that there was in a marine boiler more pressure on its bottom when the steam was down, due to the mere head of water in the boiler, than there was pressure in the top when the steam was up, due to the force of the steam, whereas now condensing marine engines work commonly at 70 lbs, and there is a boat under trial where the steam is, I believe, as high as 400 lbs

To those who are curious on the subject, I would recommend a perusal of two blue books, one being the evidence taken before a Parliamentary Commission in 1817, and the other before a Parliamentary Committee in 1839, they will find there the weight of evidence to be that the only use of high pressure steam is to dispense with condensing water, and that as a steamboat must always have plenty of condensing water in its neighbourhood, no engineer knowing his business, would suggest high pressure for a marine engine.

I have before me a model of a pair of engines which, although

[1] Address delivered by F J Bramwell, C E, F R S, one of the vice presidents of the Section, May 25 Continued from p 161

they were made not so very long ago (for I saw them put into the ship), have nevertheless an historical interest. This model shows Maudslay's engines of the *Great Western*, the first steamer built for the purpose of crossing the Atlantic. I think I am right in saying that 7 lbs. steam was the pressure employed in that vessel, and in order to extract the brine from the boiler it was necessary to use pumps as the pressure of the steam was not sufficient to expel the brine and to deliver it against the pressure of the sea.

Time does not permit of my touching upon the various improvements in boilers, condensers, expansive arrangements, and other matters which have gradually been introduced into our best engines for land and for ocean purposes. I have hung upon the wall a rough diagram showing a pair of oscillating engines as applied to driving a paddle steamer, and another showing a pair of inverted compound cylinder engines to drive a screw propeller; a model of such a pair of engines with surface condensers and all modern appliances (being Messrs. Rennie's engines for the P. and O. Company's S.S. *Pera*, by which I have had the pleasure of travelling) is now before me.

I will conclude this part of the subject by saying that to the combination of science and sound practice is due the fact of the consumption of coal having been reduced from 5 lbs. per gross indicated horse-power per hour to an average of 2½ lbs. and, in exceptional instances, to as small a quantity as 1¼ lbs. per horse per hour.

Let us now devote a little of the time that is left to the consideration of the locomotive on the common road as well as on the railway. I have before me No. 2,145, a model of the actual engine of Cugnot, in the Conservatoire des Arts et Métiers, which, in 1769, journeyed—slowly, it is true, but did journey and did carry passengers—along the roads in Paris.

It is a most ingenious machine; it has three wheels, and the motive power is applied to the front, the castor, or steering wheel, so that engine and boiler turn with the wheel precisely as, within the last few years, Mr. Perkins has caused the engine and boiler to turn with the steering wheel of his three-wheeled common road locomotive. The steam causes the pistons in a pair of inverted single acting cylinders to reciprocate, and their rods, by means of ratchet wheels, give rotary motion to the castor wheel, and thus propel the carriage. I think there is no doubt but that we must look upon this engine of Cugnot as the father of steam locomotion, as we must regard Symington's engine as the parent of marine propulsion. I have before me No. 1,926, Trevithick's engine of 1802. I have also before me a Blenkinsop rail, one that has been in actual use for many years, provided, as you will see, with teeth, into which a cogged flange on the side of the driving-wheel is geared to insure that tractive force should be obtained. This plan has been revived, within the last few years, to enable the steam locomotive to climb the Righi. A sketch of the Righi engine and rail is on the wall. It will be seen that the teeth instead of projecting from the side of the rail, are ranged between two parallel bars like the rungs of a ladder.

On the ground floor of the exhibition we have the veritable "Puffing Billy," an engine which began work in 1813, and got along without the aid of cogs by mere adhesion upon plain rails; it is a rude looking machine, but it laboured up till the date of the last Exhibition, doing its work for forty-nine years on the railway belonging to the Wylams Colliery, and, as tradition says, interesting George Stephenson, who, as a boy, saw it in daily operation.

On the ground floor, also, we have 1,954, the "Rocket," with which seventeen years after the starting of "Puffing Billy" George Stephenson carried off the prize in the Manchester and Liverpool Railway competition. The leading particulars of this engine are as follows:—A pair of 7½ inch cylinders 1′ 5″ stroke, placed at a slight inclination driving 4′ 6″ wheels, the boiler, multi-tubular, having twenty-four three and a half inch tubes, while the fire is urged by the waste blast. Before alluding to this I ought to have mentioned that in one of the Blue Books to which I have called your attention—that which gives the evidence before the Commission in the year 1817—there is a statement by a witness that in those parts there are machines called locomotives, &c.

Once more I am compelled to say that time will not admit of my entering into any detail in respect of the modern locomotive, except to remark that by the aid of excellent boilers, of high-pressure steam (140 lbs. to the inch) of considerable, although rather imperfect expansion effected by the link motion, there is provided for the use of our railways a machine which in the "passenger" form is competent to travel with ease and safety sixty miles an hour, and in the "goods" form is competent to draw a load of 800 to 1,000 tons, and to attain these results with a very commendable economy in fuel. I have put on the wall two diagrams of locomotives of the convenient form for local traffic that we call tank engines, and I have before me No. 1,957*a*, a most beautifully made sectional working model of a Russian six wheeled "goods" engine.

Within the last twenty years another description of steam-engine has acquired a prominent and important place among our prime movers, I allude to the portable engine, or to the portable engine in its more complete form of a self propelling or traction engine. The general construction of these machines borders closely upon that of the locomotive. Very great attention has been paid to all their details, and the Royal Agricultural Society of England, by their excellent arrangements for periodical trials, have stimulated engineers to devote their best energies to the subject. No. 1,942 is a model of one of Aveling and Porter's common road traction engines, capable also of acting as a source of power for driving farm yard machinery or for effecting steam-ploughing. Upon the wall I have placed rough diagrams of another kind of traction engine—a kind wherein india rubber tires are used; this is manufactured by Messrs. Ransome, Sims, and Head, and I have also placed there diagrams of the ordinary portable engine and of another most useful kind of portable engine, viz., the steam fire engine. I have there likewise a sketch of Hancock's common road steam coach which for so many months regularly plied for hire from the Bank to Paddington in opposition to the ordinary horse omnibus. Hancock's carriage was a vehicle which, in my judgment, has never since been surpassed, and I am sorry to say never to my knowledge equalled as regards the various points which should be attended to in making a steam carriage to circulate safely among horse-traffic.

There is another way in which steam may be employed as a prime mover. We saw that water in the form of the Trombe d'eau could be caused to induce a current in air and thereby to blow a forge fire, and that a rapid stream induces a current in other water, and thus drains marshy lands. Similarly steam can be caused to induce a current in water and thereby impel the water so as to raise it to a height or to force it as feed water into a boiler against a heavy pressure. When used for a mere pumping apparatus, such a mode of employing steam is very wasteful, because the steam is condensed by the water in large quantities and the water is needlessly heated at the expense of the steam; but when used in feeding a boiler into which, thus, the whole of the heat is taken, this objection does not apply. By means of that most elegant and scientific apparatus, the Giffard injector, it is possible by a jet of steam to economically induce a current in surrounding water, powerful enough to take the condensed steam itself and the water into the boiler from which the steam had previously issued. No. 1,976, which I have before me, is a sectional model of a Giffard injector.

I believe it was I who first gave a popular explanation of the principle of action of the Giffard injector, and although a scientific congress is probably not the place for a popular explanation, I will venture to repeat it. The principle may be summed up in one word, "concentration." The steam that issues from an orifice of an area of 1, when condensed, has a sectional area (according to the original pressure of the steam) of only $\frac{1}{200}$th or $\frac{1}{400}$th or $\frac{1}{800}$th as the case may be, thus the velocity remaining the same and the weight the same the energy of the steam issuing from an area of 1, is concentrated 200, 400, or 800 times upon the area due to the smaller transverse section of the liquid stream.

This concentration of energy is far more than sufficient to enable the fluid stream to re-enter the boiler from which the vaporous stream started, and so much more than sufficient, that it may be diluted by taking with it a certain quantity of water, which was employed in the condensation of the steam, and is required for the feeding of the boiler.

With a view to obtaining economy in fuel many attempts have been made to employ some other agent than steam as the means of developing the power latent in fuel, but it is imperative that I should dismiss these with a mere enumeration. A very interesting engine of this kind (because, excluding Hero's toy and smoke jacks, it is so far as I know the first proposition for obtaining rotatory motion by the aid of heat), was the fire wheel of M. Amonton, of which an account is to be found in the first volume of the "French Academy of Sciences," for the year 1699. On referring to that volume I do not see that it is stated

in terms, the machine was ever put to work, although it is said that M. Amonton made many experiments to convince the Academy of the practicability of his invention. M. Amonton proposed to have a metallic wheel revolving on a horizontal axis; the outer rim of the wheel was to be divided into a number of separate air cells, each of which had a channel so as to communicate with other cells, water-cells, arranged round the wheel nearer to the centre than the air-cells; the air cells as they passed over a fire were to be heated, and the air was to drive this water up to one side of the wheel, so as to keep that side always loaded, and thus give the wheel a tendency to revolve. The cells after leaving the neighbourhood of the fire were to be cooled by passing through water to re-contract the air ready for the next operation.

No. 1,940, which is before me, is a model of Stirling's hot-air ..., but time does not remain to describe it.

Besides hot-air engines, we have had engines working by the explosion of gunpowder, and others working by the explosion of gases. No. 1,945 is Langen and Crossley's gas engine, from which I believe extremely excellent results have been obtained.

I will now ask you to look at a tabular statement which shews the consumption of fuel in some agricultural engines, when under trial, expressed in pounds per horse-power per hour, and also in millions of pounds raised one foot high by the consumption of 1cwt. of coals. I told you how excellent were the results at which our agricultural engineers had arrived; you will see that one of those machines, working with 80lbs. steam, and of course without condensation, has developed, not a gross indicated horse-power, but an actual dynamometrical horse power, for 2.79lbs. of coal per horse per hour, giving a duty of as much as 79½ millions. This high result was obtained by the excellence of the boiler and of the combustion, as well as by that of the engine. If you look at the column of evaporation you will find that as much as 11.83lbs. of water were converted from the temperature of the boiling point into steam by the combustion of 1lb. of coal; this was due, not to the merits of the boiler alone, but to the extraordinary ability of the stoker, and to the care and labour bestowed, a care and labour far too expensive to be employed in practice. But should not we engineers endeavour to ascertain whether we cannot by mechanical means, practically, with certainty and cheapness, procure an accuracy of combustion as great, or even greater than that which can be got by the almost superhuman attention of a highly-trained man, who at the end of four hours of such work is utterly exhausted? Many forms of fire-feeders have been attempted and used with more or less success, but I cannot help thinking that in order to obtain the accurate proportioning of air and fuel, by which alone we can get efficient and economical combustion, we shall have to turn our attention in the direction of dealing with the fuel in a comminuted state, either by converting it into gas, as is done by our president, Dr. Siemens, by availing ourselves of liquid fuel, or by employing the process of Mr. Crampton, and making the fuel into an impalpable powder, that may be driven into the furnace by the air which is there to consume it.

By these, and by other means, we may hope to improve combustion. By strict attention to the proportioning of the parts of the boiler we may hope to make the best use of this improved combustion. By higher initial pressure, by greater expansion, and by the general employment of condensation, wherever practicable (and by the use of the evaporative condenser there are very few cases in which it is not practicable), we may trust that the steam-engine, even on its present principle, will be rendered more economical than it has ever yet been, and may give us more than that one-eighth or one-ninth of the total force residing in the fuel which now alone we get under the very best and most exceptional conditions. A large loss, however, must with steam-engines, as we now know them, always be incurred. We cannot hope to deal with initial pressures and temperatures corresponding with steam of a density equal to that of water, nor to carry expansion down to the point where ice would be formed in the condenser. But wonderful as the steam-engine is, worthy as it was and is of Belidor's eulogium (which I read to you), we know it is not the only heat motor, and we are aware that there are other forms of such motors which, theoretically at all events, promise higher results.

By improvements in the existing steam engine, by the invention and development of other heat motors, by the employment of the power of water and of wind, either as principal motors or as auxiliaries, we may look to further progress in the machines—the subject of my address—"Prime Movers."

I have brought before you, of necessity hastily, and therefore (and also on account of my own incapacity for the task) imperfectly, the leading improvements which have been made in prime movers from the date of the water-wheels of Vitruvius to the best-devised steam-engines of our own day. These improvements have been effected by men like Papin, Savery, Newcomen, Watt, Symington, Stephenson, and others, who were not mere makers of engines, but were men full of an ardent love of their noble profession, who followed it because of the irresistible attraction it possessed for them; followed it from their boyhood to their grave, and in that very following found their great reward. These men undoubtedly possessed that combination of science and practice, which combination, Dr. Tyndall has told us, is necessary if either science or practice is to continue to live, for, to use his expressive language, without this combination they both die—die of atrophy; the one becomes a ghost, the other a corpse.

We have every reason to believe that this combination will rapidly become even more fully developed, not only in the engineers of the present day, but in those of the next and of succeeding generations, and to such men as these we may trustfully leave the continued improvements of prime movers, resting content with the knowledge that a more general application of these machines must of necessity follow such improvements, and that the day will soon dawn when in no civilised country will there continue to be the temptation to employ intelligent humanity in the brutal labour of the turnspit, or of the criminal on the treadwheel.

OCEAN CIRCULATION[1]

THE present theories with regard to ocean circulation do not appear to account for many of the phenomena with which we are acquainted, and my object in this paper is to state very briefly my own opinions, with a view to provoking discussion, and, in this way, to forward the knowledge of a very difficult but interesting subject. I believe that there are at the present moment two rival doctrines, viz.:—

1. One which attributes all currents to the influence of the winds.
2. Another which attributes all ocean currents to gravitation.

I entirely disagree with the first doctrine, and shall address my remarks to the second. I quite think that ocean circulation is the result of gravitation, but, contrary to what I believe to be the present opinion, I hold that the cold feeding streams flow in a wave from the surface of the Polar oceans, and not from the bottom.

The points that I wish particularly to suggest for consideration are as follows:

1. That all ocean currents run from a higher to a lower level.
2. That the upward pressure produced in the equatorial regions by the constant inflow, at the bottom, of water from the Polar regions owing its high specific gravity to its contraction from cold, and, *vice versâ*, the constant inflow at the bottom of the Polar regions, of water flowing from the equatorial regions and owing its high specific gravity to its salinity, must, these streams flowing from a higher to a lower level, tend to elevate the lighter surface-water and drift it down a slightly inclined plane as a surface current.
3. That the primary cause of the origin of all ocean currents is the change in the specific gravity of sea water from one of the following causes, viz.:

(*a*) Evaporation, the vapour arising from the surface being fresh, and leaving its saline constituents behind it.

(*b*) The excess of precipitation over evaporation, particularly in the Polar seas, which by admixture with the surface-water increases its freshness.

(*c*) The expansion of surface-water through heat.

(*d*) The contraction of sea-water through cold.

It is generally admitted that currents of both air and water flowing from the equator to the poles having an excess of easterly momentum due to the velocity of rotation of the earth's surface in low latitudes as compared with the lesser velocity in high latitudes,[3] must outstrip the earth's motion, and consequently

[1] More particularly with reference to the North Atlantic Ocean, being an abstract of a paper read to the Caterham Literary Society in March last.

[2] I hold it to be impossible that you can have any such thing as an ocean level unless the different strata or layers of water from the equator to the poles are not only isometrical and isothermal, but are also of equal specific gravity; whereas the known ranges of variation of both temperature, salinity, and depth of different strata of sea water vary much in different places and in different oceans. There is a constant disturbance of equilibrium, and the constant effort to restore and equalise it produces the currents.

[3] The rotatory velocity of the earth's surface being about 1,440 feet per second at the equator, 720 feet per second in 60° of latitude, and ... zero at the poles.

flow in an easterly direction; and, on the other hand, currents of both air and water flowing from the poles towards the equator must for the same reason lag behind, and consequently appear to flow in a westerly direction. From this I argue that the cold currents from the Arctic regions to the equator do hug the western shores, and therefore cannot possibly supply the cold streams on the eastern side of the North Atlantic Ocean, south, at all events, of 50° of lat.; but that the supply must come from the Antarctic Ocean; and, on the other hand, from the same cause, that the cold water on the eastern side of the South Atlantic Ocean is water from the Arctic Ocean which underflows the equatorial stream, and as it approaches the African coast, has a portion of its stream thrown upwards towards the surface, which accounts for the surface-water of the equatorial stream near this coast being some degrees colder than that of the Guinea current to the northward of it.

I need not say that every gallon of water that flows into the North Atlantic from the South Atlantic Ocean must be returned to it in some way, either by a surface or an under-current; and I think I may safely argue that there are no surface-currents sufficient to account for the return of the volume of Antarctic water, and that, therefore, a large portion of the water returned must be from the Arctic basin, and must flow in the manner which I have previously indicated.

The surface-water in these warm regions is lifted by the inflow below it of colder and therefore heavier water from the two polar seas, it then flows off as a surface-current, and the portion of it flowing towards the north pole is deflected by the constant easterly trade winds and obliged to flow westward along the north coast of South America; a large portion of it flowing through the Carribbean Sea into the Gulf of Mexico, and thence through the Gulf of Florida. If we estimate the width of this part of the stream to occupy in the narrows thirty-two miles out of a total breadth of forty-two miles, and its depth at 200 fathoms, its velocity at an average rate of four miles per hour, *i.e.*, in the narrows, it is equal to a stream 2,650 miles wide, 60 feet deep, and running at the rate of one mile per hour, which shows that it is not the mere rivulet it is sometimes described to be. I am aware that its average rate is now said to be less than four miles per hour; but I myself travelled through the Gulf of Florida twice a month for two years, once a month when bound to the northward, keeping in the strength of the stream, and I cannot help thinking that its strength is now very much undervalued, probably in consequence of its rate, as noted, not being strictly confined to the narrows.

This stream is uplifted as it flows out of the northern entrance of the Gulf of Florida by the inflow beneath it of colder and heavier water flowing in the contrary direction from the Arctic Pole; and this, in my opinion, accounts for the arched form of the surface of the Gulf Stream as noted by Maury. Off Hatteras it is only 100 fathoms deep, and being beyond the influence of the trade winds, its easterly momentum, due to its northerly flow, inclines its course to the northward and eastward. When it gets to the northward of 40° of lat., which it does in about 50° of W. long., it appears to spread itself out over the ocean. Now this warm stream has been giving out volumes of vapour during the whole of its northward course, and has from this cause been gradually getting salter and salter; and as it gets shallower, this effect must naturally be greatly increased, besides which the temperature of the stream begins rapidly to decrease. It, in my opinion, then flows onwards towards the pole, gradually losing temperature until it meets with Polar water, which, though colder, has, owing to its admixture with glacial water, a less specific gravity than itself; it then dips below the surface, and, getting colder and colder, runs with great rapidity to the bottom of the Polar basin.

I must now try and prove that this is what takes place, and for this purpose I shall quote from Maury and Capt. Nares.

Maury, vol. ii. pp. 184 and 185.—"Capt. Duncan says, Dec. 18, 1826:—

"It was awful to behold the immense icebergs working away to the north-east from us, and not one drop of water to be seen; they were working themselves right through the middle of the ice.

"Feb. 23, lat. 68° 37′ N. long., about 63° W., about 3 P.M., the iceberg came into contact with our floe, and in less than one minute it broke the ice. Again he says, the berg was drifting at the rate of about four knots, and by its force on the mass of ice was pushing the ship before it, as it appeared, to inevitable destruction.

"Passed Midshipman S. P. Griffin, who commanded the brig *Rescue* in the American searching expedition after Sir John Franklin, informs me (*i.e.*, Maury) that on one occasion the two vessels were endeavouring to warp up to the northward in or near Wellington Channel, against a strong surface-current, which of course was setting to the south; and that whilst so engaged, an iceberg with its top many feet above the water came drifting up from the south, and passed by them like a shot, although they were stemming a surface current both against the berg and themselves. Such was the force and velocity of the under-current, that it carried the berg to the northward faster than the crew could warp the vessel against a surface- but counter-current."

Capt. Nares, in the Report of the *Challenger*, No. 2, says:—

"All the observations, however, agree in denoting that at a depth of from 80 to 200 fathoms there is a stratum of cold water lying intermediate between the superheated surface-water and the warm underlying layer, which is evidently the continuation towards the cold regions of the main oceanic flow of water."

If Capt. Nares had continued his investigations to the southward of 65° 42′ S., and it had been possible to trace this warm layer as it gradually decreased its temperature, I have no doubt that its course might be traced to the bottom.

I could adduce further confirmation of these views if space would allow me. If my readers will look at a globe, they will readily see that the Arctic Ocean is comparatively a very small sea, and that the effect of large volumes of salt water pouring into the bottom of the Polar basin must elevate the lighter, because fresher, surface-water, and consequently cause a constant outflow towards the equator. A very large stream, known as the Labrador current, runs off as a surface-current through Davis Strait, one fork dipping below the surface, at some seasons of the year, as far to the southward as 42° N., and then underrunning the Gulf Stream: and the other fork, running over the tail of the great bank, and flowing in-shore of the Gulf Stream, runs along the American coast as far south as Florida. The velocity and boundaries of all these streams vary greatly at different seasons, that is to say, the position of the sun affects the ocean as much as it does the atmospheric currents.

A further argument in favour of the cold currents flowing from the surface at the poles is that this is exactly what happens in the circulation of the atmosphere. The north-east and south-east trades, which are generally admitted to be Polar currents, descend on the equatorial side of 30° of lat.; besides in no other way that I can see can you obtain a sufficient motive power. A *primum mobile* depending on the lateral pressure of a column of Polar water as opposed to the lesser weight of a column of temperate or of equatorial water, assuming the length of the ocean (counting say from 70° of lat. to the equator) to be 4,200 miles, and its mean depth to be 3 miles, *i.e*, a length of 1,400 times its depth, appears to me to be a very insufficient power to move the volumes of water which we know to be constantly circulating between the equator and the poles. (An ordinary sheet of note paper has a length equal only to 928 times its depth.) If, however, it is allowed that the cold streams flow from the surface, and that they do not dip till they reach 70° of lat.[1] (the Labrador current, as before stated, dips much further towards the equator, sometimes in 42° N), you have still a fall of nearly 3 feet 7 inches per mile of lat. to the equator.[2] I have said sufficient to indicate very briefly my opinions. The arguments I have recently read on this subject appear to be based on the idea that currents flow in one lateral sheet from the pole to the equator. If they did this, there would be no reason why the surface-currents should not flow in a similar way. But they do not; and, if of the depth lately suggested, *i.e.*, 3,000 feet, the Arctic basin could not receive them if they did. The *Challenger* observations seem to me to entirely disprove this view of the subject.

There is a wonderful similarity between oceanic and atmospheric circulation, which I propose more specially to point out at some future time. If we wish to know how the N.E. trades and the S.W. winds pass one another in the upper regions of the atmosphere, let us question the currents of the ocean, and the Labrador current will suggest an intelligible reply. If, on the other hand, we want to know what is the system of ocean circulation, let us ask the currents of the atmosphere; and the Polar currents (*i.e.*, the trade-winds) and the equatorial currents (*i.e.*, the westerly winds of the temperate zones) will strongly suggest to us the answer. It is quite true that there is no salt in the atmosphere, but there is, instead, vapour, which plays as important a

[1] They at most, if not at all, seasons dip in a much lower latitude.
[2] Estimating the depth of the ocean as 2,500.

its circulation as salt does in that of the ocean. In conclusion, I would say, look at the isotherms between 65° 42′ S., and 50° 1′ S. published in Report No. 2 of the *Challenger*.

May 10 DIGBY MURRAY

ANCIENT GLACIERS IN AUVERGNE

HAVING just returned from Auvergne, where I have been searching for the tracks of former glaciers along the old volcanoes of the Monts Dome and Mont Dore, I send a few notes to NATURE, in the hope that they may prove useful to other geologists who may explore that most remarkable and interesting country during the ensuing summer. My companions were three members of the Cotteswold Naturalist's Field Club, Sir W. V. Guise (the President), Sir David Wedderburn, and Mr. Lucy, all well versed in the phenomena presented by glaciation.

With regard to the Monts Dome and the country round Clermont Ferrand, it is evident that no glaciers have occupied the vales since the outpouring of the later lava currents, and the volcanic outbursts of the craters of the Puys de Dome; and yet, as I have already mentioned in the pages of NATURE, M. Le Coq discovered remains of the Mammoth, Tichorhine rhinoceros, and Spermophilus, which had been washed into drifts and fissures in the most recent lava currents of Volvic and Gravenoire near Beaumont. Such drifts deserve *especial attention*, as they appear to owe their origin to a period when there was greater transportation of angular and subangular débris by rain-wash and melting snow, or neve, than there is at present. It may have been during this period that the northern animals became inhabitants of Central France. Such angular and sub-angular drifts may be seen in various localities as in the road which descends from the south side of Gergovia, between the village of Merdogne and the high road to Clermont Ferrand, and again at the base of the Puy Dallet, where the high road descends to the village of Dallet, and atmospheric drifts are seen to overlie the old river shingle of an ancient Allier. The geologist who examines the source of the old basaltic current which Mr. Scrope believes to have flowed from the Puy de Berzé, near St. Genest de Champanelle, and to have extended over the freshwater strata of Gergovia, may learn a good lesson as regards the deceitful appearances of glaciation often set up by granitic rocks. Most of the country between Ceyrat, near Mont Rognon, and Theix looks regularly "moutonéed," and may mislead anyone who has not become convinced, by careful examination, that this appearance is owing to atmospheric weathering, and the desquamation of the granitic rocks which separate at the joints and weather into rounded boulders assuming sometimes the aspect of blocs perchés. There are no signs of glaciation, however, among the older basalts which overlie the granite rocks, in so many localities, and which ought to show it if glaciation there had been.

In the country of the Monts Dore the evidence is most puzzling, and in some respects contradictory. Arrived at Monts Dore des Bains we searched carefully for glacier evidences in the valley of the Dordogne and the gorges de l'Enfer and de la Cour, and though some of the knolls are rounded, and there is a vast amount of débris from the rocks around and above, nowhere could we see signs of true moraines, perched blocks, or the usual evidences of glacier action; and certainly the position of the masses of rock called "Les Trois Diables," which I believe are by some set down as blocs perchés, are far too close to the rocks in situ to allow us to attribute their transportation to a glacier rather than to a fall from the precipices above. They belong to the "Chemins du Diable," which are preparing for a similar descent. Again, and I must here state that I arrived at conclusions contrary to those of my friends, I believe that a glacier has descended, in long ago ages, down the valley of the Dordogne, but so long since that the vast masses of débris which have fallen from the rocks which skirt the valley, combined with the wear and tear of atmospheric agencies, the constant shifting of the bed of the Dordogne and its hundreds of tributary rills which during the melting of the snows everywhere wash, roll, wear, and transport the débris of the vale, all have assisted in destroying and masking any glacier evidence there may have been in past times. I was led to this conclusion from the examination of the higher ground, and the detection of what I believe to be moraine matter and transported rock masses, on the road between Mont Dore des Bains and Latour, as on the platform below the Rochers de Beauzac, &c.

The Tranteine valley, where Dr. Hooker discovered the transported rock-masses and which he has already described in NATURE, lies at right angles to the Dordogne valley, runs due south, and faces the Cantal. It is difficult to understand why glacier relics should be preserved in this valley and none in that of the Dordogne. This difficulty, however, vanishes somewhat when surveying the difference in the contour of the ground, the difference in the watershed of streamlets, and the low hill against which the great rock-masses are stranded, consisting of moraine matter overlying beds of basaltic lava. The Tranteine valley may be reached by passing over the Col between the Pic de Sancy and Puy Ferrand, and turning down the gorge to the south, or by the long roundabout route through the village of Latour. We selected the former for our first attack, taking the Latour route two days later. I would here recommend as guide, Guillaume Pierre, of the Hotel Chabourg ainé, to whom I pointed out certain phenomena on descending the gorge, which I think are worthy of notice. I also recommend no one to attempt this route who is not a good walker—"Facilis descensus," &c. The transported rocks, one of which Dr. Hooker sketched, lie stranded in moraine matter, which again rests on beds of black basalt, as may be seen at the little waterfall of the Tranteine stream. The rocks themselves come from the Pic de Sancy, and consist of what Scrope calls "porphyritic trachyte," but perhaps now they may be termed a granitic felstone or a felstone porphyry. Dr. Hooker calls them domite, but this term is now usually applied to the white, light, pulverulent rock like that of the Puy Sarcoui in the Puys de Dome. On the right and left of the transported rocks the hills are rounded, and blocs perchés are seen resting on them. There is a fine section on the Tranteine stream, en route to Picherande, where large transported rock-masses may be seen resting on glacial till. Following the valley down to the bridge which crosses the Tranteine river between Latour and Picherande, the observer will find rounded surfaces and transported moraine matter, but a vast deal of atmospheric weathering has gone on since the days when the ice passed away.

Travelling down the valley of Besse to Lake Pavin, I thought I recognised glacier action; and again at the head of the valley of Chambon; but if glaciers ever flowed down these valleys, it is evident that they must have done so before the eruption of the Puy de Tartaret or the Puy d'Eraignes. The occurrence of the volcanic cone of Tartaret right in the middle of the valley of Chambon is fatal to the supposition that a glacier of any size ever came down from the mountains since the outburst of the cinders and lavas of Tartaret.

If, therefore, after three visits to the volcanic regions of Central France I may be permitted to give a broad view as to the time when glaciers swept down the valleys of Mont Dore, I should say that it was in days of old, when the Alpine glaciers reached the Jura, and the Rhine glacier swept over to the plains of Bavaria, when there were glaciers in the Vosges and in the Black Forest; and that when those ice rivers melted and passed away, so also did the glaciers of Mont Dore. W. S. SYMONDS

Pendock Rectory, Tewkesbury, June 5

NOTES

THE French Government has formally decided to accept the principle of obligatory primary instruction. M. Waddington proposes, moreover, to organise four great Universities in France, viz., at Paris, Lyons, Bordeaux, and Nancy, each of which will have an independent status. M. Waddington's legislation is entirely in accordance with the views which have been so frequently advocated in NATURE. The sooner that similar reforms are universally made the better it will be for the advance of solid education. The tendency, we are glad to think, to follow the German example, is spreading, and we hope it will soon reach our own country. Such institutions as Owens College, the Yorkshire College, and other similar bodies, cannot too soon spring into universities with the vigour of youth. The admirable vigour and promptness with which the French Government has carried out the much needed educational reform is in the highest degree hopeful.

ACCORDING to the photographs taken daily at Montmartre by M. Janssen, no spots have been now noticed on the sun since March 25. At the last meeting of the Paris Academy, M. Leverrier announced that in addition to the solar work to be carried on by M. Janssen in the new physical observatory of Paris, M. Cornu has been appointed to make corresponding researches in the National Observatory. It is extremely encouraging to witness astronomical research taken up with such vigour by France as well as by Germany.

WE regret to have to record the loss of one of the most indefatigable of our working naturalists in the death of Mr. Edward Newman, which took place on the 12th inst. at his residence at Peckham at the age of 75. Mr. Newman took up the study of natural history when a young man, as a relaxation from the labours of an active commercial life, and continued ardently devoted to it to the close of his life. He soon established himself as an authority in two branches especially, entomology and pteridology. His "Grammar of Entomology" was published as long ago as 1835; and his "British Ferns" still holds its place, notwithstanding a tendency to excessive species-splitting, as a standard manual of the ferns of these islands. He was the editor of the *Zoologist* and *Entomologist*, as well as of the *Phytologist*, which has ceased to appear for some years; and he was a large contributor to periodical literature, having had the control of the natural history department of the *Field*. Mr. Newman was a Fellow of the Linnean and Zoological Societies, and of several foreign academies, and has been president of the Entomological Society.

THE friends and admirers of the late Daniel Hanbury will be glad to learn that a selection from his papers and essays, with a memoir by Mr. Thomas Ince, F.L.S., is now in the press and will be ready for publication in a few days. The book will consist chiefly of papers on Pharmacology and Botany, and will be illustrated by a portrait engraved on steel and by a number of wood engravings and lithographs. Messrs. Macmillan and Co. are the publishers.

IN addition to the ordinary courses of lectures for science students at South Kensington this year, the Lords of the Committee of Council on Education are making arrangements for a course of sixty lectures on the scientific instruments in the Loan Collection. Their Lordships are in communication with the leading men of science in the country to enable them to carry out the important object they have in view.

ACCORDING to tidings which have been received at Berlin from the German expedition under Dr. Finsch, now exploring Western Siberia, it appears that the expedition left Tyumen on April 13, and proceeded to Omsk. From thence the explorers followed the course of the River Irtish across the steppes as far as Semipalatinsk, where the Russian Governor gave them a very hospitable reception. The travellers made their next halt at a Khirgiz *yourt*. From thence they were at the time of writing about to undertake an expedition into the mountains on the Chinese border. In the second half of the present month the explorers hoped to reach Bernaul, after which it was their intention to follow the course of the river Ob downwards. Dr. Finsch's letters are stated to contain some very instructive and interesting intelligence on animal and vegetable life in the regions traversed. The other expedition undertaken specially to explore the mouth of the river Ob started from Moscow on May 11. The two expeditions are to join at the mouth of the Ob and to return to Germany in company. They are expected back in the course of the autumn.

DR. W. PETERS has lately communicated to the Royal Academy of Sciences of Berlin a description of a very fine new species of wild sheep which is found in Eastern Mongolia, north of Pekin. Dr. O. von Moellendorff, of the Imperial German Legation at Pekin, has forwarded to the Zoological Museum of Berlin an adult male specimen of this animal, which Dr. Peters proposes to call *Ovis jubata*, from the long hairs which adorn its chest.

AT the meeting of the Zoological Society on Tuesday last, Mr. H. E. Dresser, F.Z.S., exhibited a series of specimens of a very fine new species of Snow Partridge, collected by Mr. C. G. Durnford in the Taurus Mountains, and described it under the name of *Tetraogallus tauricus*. This bird, which seems to be restricted to the Taurus range, where it inhabits the higher and more inaccessible mountains, is nearest allied to *Tetraogallus caspius*, but differs in being much larger, in having the upper parts much paler and washed with buff, the hinder portions of the neck and the fore-parts of the back ashy buff, almost unvermiculated, a broad pectoral band of ashy buff spotted with black; the flank feathers clear blue grey in the centre, with a chestnut stripe on each side, and an outside margin of black; and the lower breast, instead of being broadly marked with black, is ashy buff, finely vermiculated with blackish grey. This makes the fifth species of Snow Partridge now known to inhabit different parts of the Palæarctic region, the others being *T. caspius*, from the Caucasus, *T. himalayensis*, from the Himalayas, *T. altaicus*, from the Altai range, and *T. tibetanus*, from Thibet. Mr. Dresser also exhibited and described, under the name of *Limicola sibirica*, a new species of broad-billed Sand-piper from China, which differs from *L. platyrhyncha* in having the upper parts rich rufous, as in *Tringa minuta*, instead of deep blackish brown, as in the former species.

THERE are now living in the Zoological Society's Gardens, Regent's Park, four specimens of the Giant Tortoises of the Galapagos Archipelago, two having been brought home by the *Challenger*, and deposited by Prof. Wyville Thomson, and two by Commander W. E. de Cookson, of H.M.S. *Peterel*. They were all obtained from Albemarle Island, and are of the species known as *Testudo elephantopus*. These, together with the even larger specimens of *Testudo indica*, from Aldabra, form an unequalled series of living Giant Tortoises.

THE Very Rev. Principal Tulloch, D.D., Vice-Chancellor of the University of St. Andrews, was entertained at dinner on Monday night at St. James's Hall, by a large and influential gathering of the members of the St. Andrews Graduates' Association. Dr. Richardson, F.R.S., Assessor of the General Council in the University Court, presided, and was supported by the Earl of Elgin, Mr. Lyon Playfair, M.P., Dr. Lush, M.P., Sir Joseph Fayrer, K.C.S.I., and a large number of members of the asso-

ciation. The reception given to Principal Tulloch was enthusiastic. The Principal spoke of the past and present of the University with which he is connected. Sir Joseph Fayrer replied for the toast of the University of Edinburgh, and Mr. Danby Seymour eloquently proposed the health of the chairman. It is gratifying to find that this Scottish University is represented by so many eminent men of science in London; we would wish to see the example followed by other Universities.

UNDER the title of "Endowment of Research in America," the *Academy*, at President Gilman's request, gives publicity to the following circular: "The trustees of the Johns Hopkins University hereby offer to young men from any place ten fellowships, or graduate scholarships to be bestowed for excellence in any of the following subjects:—Philology, literature, history, ethics, and metaphysics, political science, mathematics, engineering, physics, chemistry, natural history. The object of this foundation is to give scholars of promise the opportunity to prosecute further studies, under favourable circumstances, and likewise to open a career for those who propose to follow the pursuit of literature or science. The University expects to be benefited by their presence and influence, and by their occasional services; from among the number it hopes to secure some of its permanent teachers.—*Conditions*: 1. The applications must be made in writing prior to June 1, 1876. The decision of the trustees, will, if possible, be made before July 1. 2. The candidates must give evidence of a liberal education (such as the diploma of a college of good repute); of decided proclivity towards a special line of study (such as an example of some scientific or literary work already performed); and of upright character (such as a testimonial from some instructor). 3. The value of each fellowship will be $500, payable in three sums, viz: $100, Oct 1; $200, Jan. 1; $200, June 1. In case of resignation, promotion, or other withdrawal from the fellowship, payments will be made for the time during which the office may have been actually held. 4 Every holder of a fellowship will be expected to render some services to the institution as an examiner, to give all his influence for the promotion of scholarship and good order—and in general to co-operate in upholding the efficiency of the University, as circumstances may suggest. 5. He will be expected to devote his time to the prosecution of special study (not professional), with the approval of the president, and before the close of the year, to give evidence of progress by the preparation of a thesis, the completion of a research, the delivery of a lecture, or by some other method. 6. He may give instruction, with the approval of the president, by lectures or otherwise, to persons connected with the University, but he may not engage in teaching elsewhere 7. He may be re-appointed at the end of the year. 8 These regulations are prescribed for the first year only." For further information inquiries may be addressed to D C. Gilman, president of the Johns Hopkins University.

Iron, on the authority of the Icelandic paper *Nordlingr*, states that two enterprising Icelanders, named Jow Thorkellsson and Sigindur Kraksson, have explored the volcanic region of the Dygyur Jelden. They started on their hazardous expedition from the Bardadal on Feb. 7, and in the course of their two days' exploration they succeeded, under great difficulties and dangers, in descending into the crater of the volcano Asya, where, at about 3,000 feet below the upper margin, they reached the bottom, and found themselves on the brink of a lake of seething hot water, which was apparently of great depth. Near the southern extremity of this lake the ground was broken up by fissures and pools, which prevented further progress in that direction, while the entire space resounded with the noise of loud subterranean thunder. North of the great crater the explorers found an opening about 600 feet wide, which appeared to be of about equal depth, from which issued dense masses of sulphurous smoke, accompanied by loud and deafening sounds.

THE Royal Society gave on Wednesday last week a *conversazione*, to which, for the first time, ladies were invited. The experiment was eminently successful.

THE members of the Birmingham Natural History and Microscopical Society propose to visit on Saturday next the Loan Collection of Scientific Apparatus, the South Kensington authorities having promised to afford them every facility. On the same day, under the guidance of Mr. W. R. Hughes, the members of the Society will visit the Crystal Palace Aquarium.

W. B. LOWE has been elected to a Foundation Scholarship at St. John's College, Cambridge, for proficiency in Natural Science. Houghton, Man, and Slater to Exhibitions.

AN examination will be held at Exeter College, Oxford, in October next, for the purpose of filling up a Natural Science Scholarship tenable for four years during residence, and of the annual value of 80*l*. There is no limit of age for this Scholarship. The examination will be in biology, chemistry, and physics.

THE Society of Geography of Paris, appointed some time since, a special committee on Commercial Geography. We learn from the *Explorateur* that this Committee is starting a new and independent Geographical Society. We have also received a prospectus announcing the formation of a Paris Society of Zoology.

THE Academy of Zurich has granted a doctorship in Medicine for the first time to a young lady, Miss Francisca Tiburtias, aged 23.

M. W. DE FONVIELLE has had a spectroscope constructed with a graduated screen permitting the quantity of light admitted to be diminished in a known ratio. The moving force being regulated at will, the radiometer can be put in a state of rotation under the rays of the most scorching sun and record taken of the motion very easily. With such an apparatus it was shown by comparison with a standard oil-lamp burning forty-two grammes an hour, that on June 9, at 4 o'clock precisely, the radiating force of the sun was equal to fourteen lamps at a distance of twenty-five centimetres from the axis of the radiometer. The apparatus is tried daily at La Villette gas-works, and results of the comparisons will be tabulated and discussed.

PROF. O. C. MARSH has discovered a new sub order of Pterosauria from the Upper Cretaceous of Western Kansas, North America, differing from the typical Pterodactyles in that no teeth were present in either jaw. The name given to the genus, *Pteranodon*, signifies this. The species was of large size, the skull of *Pteranodon longiceps* being thirty inches from the occipital crest to the end of the pre-maxilla. It must be remembered that the absence of teeth in a Pterodactyle *need* not lead to the inference that it is any way more nearly related to birds than the tooth-possessing species, because the character may have been acquired quite independently.

THE April number of the *Bulletin* of the French Geographical Society contains a memoir of the late Jules Duval, by M. E. Levasseur, an Account of a Journey in Herzegovina, by M. E. De Sainte-Marie, and Notices of the Basques, by Major V. Derrecagaix.

REINWALD AND CO., of Paris, have just added to their "Bibliotheque des Sciences Contemporaines" a work on Anthropology, by Dr. Paul Topinard, with a Preface by Prof. Paul Broca. Williams and Norgate are the English publishers.

In the *Monthly Notices* of the Royal Society of Tasmania for 1874 occur some interesting abstracts of papers read before the Society, including notices of the Angora goat, some species of Tasmanian birds, introduction of the salmon into Tasmanian waters, the Silurian fossils of Tasmania, the Tertiary basin of Launceston, and a list of the plants of Tasmania, prepared in 1875 by Baron Fred. von Mueller. To the notices are appended the meteorological observations made during the year by Mr. F. Abbott at Hobart Town, and by Mr. W. E. Shoobridge at New Norfolk. From the monthly notes we observe that meteorological observations are also made at Port Arthur, Mount Nelson, King's Island, and other places, and sent to the Society, but the results are not published, nor so far as we are aware have they been published since 1866. We hope the Society may soon be in a position not only to publish these results, but also results from a sufficient number of stations, so as to represent adequately the meteorology of the island.

The additions to the Zoological Society's Gardens during the past week include a Cariama (*Cariama cristata*) from South-east Brazil, presented by Capt. W. C. Chapman, H.M.S. *Dido*; two Black-eared Marmosets (*Hapale penicillata*) from Brazil, presented by Mr. G. Newton; a Rose-ringed Parakeet (*Palæornis docilis*) from West Africa, presented by Mrs. Haywood; a Hyacinthine Maccaw (*Ara hyacinthina*) from Brazil, presented by Mr. H. Wilson; a Moor Monkey (*Semnopithecus maurus*) from Java, a Bay Antelope (*Cephalophus dorsalis*) from West Africa, purchased; two Vulturine Guinea Fowl (*Numida vulturina*) from East Africa, a Puma (*Felis concolor*) from Central America, deposited.

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, No. 3.—According to the kinetic theory of gases, supposing the gaseous molecule to consist of only one atom, the relation of the two specific heats (as Clausius has shown), would be 1·666. The lower number obtained by experiment for several gases may probably be explained by the complex constitution of their molecules. It seemed desirable to MM. Kundt and Warburg to determine experimentally the specific heat of mercury vapour, which has been considered by chemists to consist of monatomic molecules. Their method was to produce a sound in two glass tubes placed end to end, and containing, the one mercury vapour, the other air. Having introduced powder into the tubes, they observed the distances between the nodes of vibration. Applying a formula of acoustics which comprehends, among other things, the densities, the temperatures, and the relation of the specific heats, and taking, as value of this relation in the case of air, the number 1·405, they obtain, for mercury vapour, the number 1·67, which may be considered as fully in accord with the number 1·666 furnished by theory.—In an interesting paper which follows, M. Colley, of Moscow, examines a particular case of work done by the galvanic current. Suppose a current to pass through a vertical column of some salt, *e.g.* nitrate of silver; both electrodes being in this case of silver. In a given time a certain quantity of silver is liberated and deposited. Now, if the current pass up the column, it lifts this silver against the force of gravity, and so does mechanical work, which, in the opposite case (of the current passing down) is not done. It appeared, then, as theory anticipated, that the downward current in such a column (as measured by the galvanometer), was stronger than the upward, and the difference was not greater than theory indicated. But both with a battery current and with that from a Clarke magneto-electric machine, it was considerably less. The author, seeking an explanation, regards as untenable the general views regarding passage of currents through liquid conductors, the phenomena of passage from the solid to the liquid conductor being generally ignored; and he thinks the facts favour Helmholtz's view, which regards the liquid, with the electrodes immersed in it, as a condenser of very great capacity. Weak currents which cannot pass through the liquid yet produce a polarisation of the electrodes (charge of the condenser). With strong currents the only difference is that as soon as the difference of tension has reached a certain limit (maximum of the electromotive force of polarisation), all newly arriving quantities of electricity can unite through the liquid. M. Colley shows how his results are deducible from the state of things thus supposed.—A number of experiments on electric clocks (with Tiede's pendulum) are described by Dr. Joseph Brunn.—Of the few remaining original papers we note one by M. Chwolson on the theory of interference-phenomena.—A good experiment for illustrating the explosive character of a mixture of oxygen and hydrogen gases is described by M. Rosenfeld.

Archives des Sciences Physiques et Naturelles, Jan. 15.—In the opening paper of this number M. de Candolle inquires into the causes of unequal distribution of rare plants on the Alpine chain (See NATURE, vol. xiii. p. 516).—M. Favre follows with a note on the glacial and post-glacial strata of the southern slope of the Alps, in the canton of Tessin and in Lombardy.—M. Pictet discusses the application of the mechanical theory of heat to the study of volatile liquids, and finds some simple relations between the latent heats, atomic weights, and tension of vapours.—A series of meteorological observations from the coast of Labrador, by Moravian missionaries, is communicated by M. Gautier (See NATURE, vol. xiii., p. 60).

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 18.—"On the Organisation of the Fossil Plants of the Coal-measures.—Part VIII. Ferns continued, and Gymnospermous Stems and Seeds." By Prof. W. C. Williamson, F.R.S., Professor of Natural History, Owens College, Manchester.

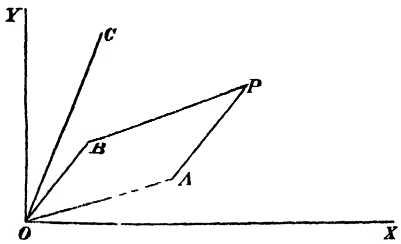
The author described the stem of a new fern, in which the principal vascular axis formed a cylinder enclosing a medulla, as in some Lepidodendra. This vascular cylinder gives off secondary bundles, to petioles, and rootlets, and each vessel is filled with tylose. Two kinds of Fern-sporangia were described—one Polypodiaceous, with a straight, vertical annulus; the other, with the annulus horizontal and subterminal, exhibits a type seen in the recent Schizeaceæ and Gleicheniaceæ. But the chief subjects of the memoir are the stems and seeds of Gymnosperms. Of the former various modifications of the *Sternbergian Dadoxylons* are described, and shown to correspond very nearly to many recent conifers, though with distinctive features of their own, especially in the structure of their woody fibres, and in the leaf-bundles of some species being given off in pairs. The author still excludes the Sigillariæ from the Gymnospermous group.

The most important novelties are the Gymnospermous seeds, exhibiting their internal organisation, found in France by M. Grand-Eury, and by the author in this country. Of these he describes a number of new genera and species in addition to the Trigonocarpous previously described by Mr. Binney and Dr. Hooker. The most remarkable of these is one designated *Lagenostoma ovoides*, in which a large flask-shaped cavity, inclosed within a crenulated canopy, occupies the apical end o the seed, between the apex of the endosperm and the exostome. Brongniart believed, with reason, that such cavities have originated in the absorption of the apex of the nucleus, leaving the corresponding part of the nucular membrane to form the cavity or "lagenostome." In this lagenostome large pollen-grains are found in many cases. Brongniart designates it the "Cavité pollinique." Examples of several other seeds presenting generic and specific modifications of the same type, as well as several species of the well-known genus Cardiocarpum and of Trigonocarpum. In all these the primary nucleus seems to have been absorbed, being now only represented by the investing nucular membrane. Within this is an inner structureless bag, which, in some of the Cardiocarpa, is filled with parenchyma, and which appears to represent the *secondary* perispermic membrane, or what is really the endospermic membrane, or *primary* embryosac of the Gymnosperms. The intimate structure of Trigonocarpum agrees with Dr. Hooker's description of it so far as the longitudinal sections are concerned, save that here, also, a "cavité pollinique" exists. Transverse sections show that the well-known sandstone casts of Trigonocarpum do not represent the external form of these fruits, but are *casts of the interior* of the hard endotesta. This latter was not trigonous externally, like the common specimens, but had twelve longitudinal ridges, three of which, corresponding with those of the sandstone casts, were more prominent than the rest. The endotesta was invested by a delicate parenchymatous sarcotesta. All these seeds appear to have Cycadean

rather than Coniferous affinities. One winged seed alone (Polypterospermum), from the uppermost coal-measures at Ardwick, resembles a true conifer. In conclusion, the author calls attention to the number of yet unknown stems and leaves of Phanerogams, which must have belonged to the numerous seeds now known to exist in the coal-measures of England, France, and North America.

Mathematical Society, June 8.—Prof. H. J. Smith, F.R.S., president, in the chair.—Mr. A. B. Kempe spoke on a general method of describing plane curves of the *n*th degree by link-work. He first described what he calls the *reversor* and the *multiplicator*. (These were first described by him in the "Messenger of Mathematics," vol. iv. pp. 122-3, in a paper "On some New Linkages.") He then explained the *additor* and the *translator*. Let $\phi(x, y) = 0$ be the equation to any plane curve of the *n*th degree, and let P be any point on the curve; construct the link-work parallelogram $OAPB$ in which

$$OA = BP = a,\ OB = AP = b,$$



and let the angle $AoX = \theta$, and the angle $BoX = \phi$, then—

$$x = a\cos\theta + b\cos\phi$$

$$y = a\cos\left(\theta - \frac{\pi}{2}\right) + b\cos\left(\phi - \frac{\pi}{2}\right)$$

Substitute these values of x and y in $\phi(x, y)$, expand and convert powers of cosines into cosines of multiple angles, and then the products of cosines into the cosines of the sums and differences of angles, we shall then get—

$$\phi(x, y) = \Sigma[A\cos(r\phi \pm S\theta \pm \alpha)] + C,$$

where r, s are positive integers, and $\alpha = \frac{\pi}{2}$ or 0 and A and C are constants. The author then proceeded to show how the constructions could be effected by his link-work, and he pointed out that his method would not be practically useful on account of the complexity of the link-work employed, a necessary consequence of the perfect generality of the demonstration. The method has, however, an interest as showing that there *is* a way of drawing any given case; and the variety of methods of expressing particular functions that have already been discovered renders it in the highest degree probable that in every case a simple method can be found. There is still, therefore, a wide field open to the artist to discover the simplest link-works that will describe particular curves. Mr. Kempe further pointed out that the extension of the demonstration to curves of double curvature and surfaces clearly involves no difficulty.—Mr. S Roberts then gave an account of a further note on the motion of a plane under certain conditions. (The former paper was read June 8, 1871).—Mr. J. J. Walker communicated a method of reducing the equation of a nodal plane cubic curve to its canonical form, in which the lines of reference are the nodal tangents and axis of inflexion.—Prof. Cayley described a surface connected with the sinusoid. Its edge of regression was given by the equations $x = r\cos\phi$, $y = r\sin\phi$, and $z = r\cos 2\phi$.—The president made a few remarks in connection with a recent note by M. Hermite, on a theorem of Eisenstein's.

Zoological Society, June 6.—Dr. A. Günther, F.R.S., vice-president, in the chair.—The Secretary exhibited some specimens of a Land-crab, from Ascension Island (*Geocarcinus lagostoma*), which had been presented to the Society by Dr. J. B. Drew, and read a note by Dr. Drew on their habits.—Mr. Sclater exhibited skins of a male and female of the new Pheasant from Borneo lately described by Mr. Sharpe as *Lobiophasis bulweri*. These birds had been obtained alive for the Zoological Society of Amsterdam, but the female only had lived to reach Amsterdam.—A letter was read from Mr. J. H. Gurney, containing some notes on the breeding of a pair of the Polish Swan (*Cygnus immutabilis* of Yarrell), and a description of the young birds.—A communication was read from Dr. Julius von Haast, F.R.S., containing some notes on the skeleton of *Ziphius Novæ Zealandiæ*.—A second communication from Dr. Julius von Haast, F.R.S., contained some notes on *Mesoplodon floweri*.—A communication was read from Dr. G. E. Dobson, containing a description of certain peculiarities in the structure of *Mystacina tuberculata*, which induced him to believe that this Bat used its feet for purposes of locomotion on branches and leaves of trees.—Mr. A. H. Garrod read the first part of a memoir on certain anatomical characters which bear upon the major divisions of the Passerine Birds.—A communication was read from Mr. E. L. Layard, C.M.G., containing notes on the Birds of the Navigators and Friendly Islands, with some additions to the ornithology of Fiji.—Mr. H. Adams and Mr. G. French-Angas communicated descriptions of five new species of Land Shells from Madagascar, New Guinea, Central Australia, and the Solomon Islands.

Royal Microscopical Society, June 7.—Mr. H. J. Slack in the chair.—A number of presents to the society were announced, including some rich diatomaceous earth from Santa Monica, near Los Angelos, sent by Mr. Hanks, of San Francisco.—A paper on a photograph of Nobert's bands, by Count Castracane, was read to the meeting and was supplemented by a short communication upon the same by Mr. H. C. Sorby.—Mr. Henry Davis gave an interesting account of some new observations which he had made upon *Chonochilus volvox*, and illustrated his remarks by drawings showing the principal features of the genus as distinguished from the Melicertians.—Mr. Chas. Stewart described and exhibited under microscopes in the room some minute spines found only round the pentagonal opening on the under side of the shell of the Echinoderms; he also gave a description of the remarkable structure of the large lachrymal gland of the common turtle, and exhibited preparations.

Victoria Institute, May 29.—Annual Meeting.—The Right Hon. the Earl of Shaftesbury, K.G., in the chair. The address was delivered by the Rev. Prof. Birks, of Cambridge. 115 members and associates have joined during the year, and the total number has risen to 690, two-thirds of whom are country and foreign members. The president, on behalf of the Institute, presented a testimonial to Capt. F. Petrie, who had acted as honorary secretary and editor of the "Transactions" for the last five years and a half.

BERLIN

German Chemical Society, May 22.—C. Scheibler, vice-president, in the chair.—A. Fischer described a modified water air-pump, remarkable for its cheapness. The brass instrument is sold by Messrs. Dreyer and Rosenkranz in Hanover for ten shillings, or with a manometer fixed to it for twenty shillings. It can be fixed to any laboratory table.—A. Horstmann confirmed observations by F. Isambert respecting the dissociation of the combination of ammonia with chloride of silver. For every degree of temperature a certain pressure can be observed, at which the separated bodies do not re-combine and the combination ceases to be decomposed. He also observed the existence of two compounds of the formulæ $AgCl.3NH_3$ and $2AgCl.3NH_3$.—A. Steiner has obtained the following combination of sulphuretted hydrogen with fulminic acid by passing H_2S into fulminate of mercury—

$$C_2H_2N_2O_2 + H_2S = C(NO_2)H_2 - CS.NH_2,$$

microscopical crystals, yielding, with a surplus of sulphuretted hydrogen, oxalic acid, sulphocyanide of ammonium, and sulphur—

$$2(C_2H_4N_2O_2S) + H_2S = 2CN_2H_4S + C_2H_2O_4 + S.$$

The same chemist by treating fulminurate of ammonium with sulphuric acid has obtained nitro-acetonitrile, $CH_2NO_2.CN$ (hitherto unknown), beautiful colourless crystals, fusing at 40°, burning with a brilliant flame. The substance is not identical with fulminic acid, because with mercury and silver it forms monobasic and not dibasic salts. He also described two bodies formed by the reaction of ammonia on fulminate of mercury, of the formulæ $C_6H_{11}N_9O_3$ and $C_7H_{13}N_{11}O_3$, guanidines, containing fulmi-guanurates. At the end, double salts of fulminate of mercury with sulphocyanide of potassium and ammonium, and also with cyanide of potassium were described.—E. Demole published researches on a body lately described by Baumstark, C_4H_9IO, under the name of ethylidene-iodo-oxethyl. Mr. Demole's researches lead him to suppose that this body is derived from ethylene and not from ethylidene.—A.

Laubenheimer has found nitro-meta-chloro-nitrobenzol to exist in four modifications, chemically identical but differing in physical and crystallographical respects. The same chemist has transformed the above-named substance by boiling it with an alcoholic solution of potash into nitro-chloro-phenol and mono-chloro-chinone, $C_6H_3ClO_2$; and by treating it with aniline into chloro-nitro-diphenylamine, $C_6H_3Cl(NO_2) . NH . C_6H_5$. Nascent hydrogen transforms dinitrochlorobenzol into chlorinated phenylen-diamine.—L. Mears has studied the action of nitric acid on benzanilide, which yields three isomeric nitro-benzanilides.—W. Grethen has transformed acetanilide into ortho- and para-nitro-acetanilides, formed simultaneously.—C. Sennewald described meta-amido-benzanilide. The same chemist has transformed anhydro-benzoyl-diamidobenzol—

$$C_6H_4 . N . C . C_6H_5 . NH,$$

into the amylic substitution-compound—

$$C_6H_4 . N . C . C_6H_5 . N . C_5H_{11},$$

and into the corresponding ethyl-compound.—H. Hübner and F. Frerichs have studied the action of iodide of cyanogen on diamidobenzoles. The result is expressed by the equation—

$$2C_6H_4(NH_2)_2 + CNI = C_{13}H_{12}N_4 = C_6H_4(NH_2)N - C - N(NH_2)C_6H_4.$$

—O. Hesse reported on the properties of a new alkaloid called cusconin.—Th. Collen described the action of sulphuric anhydride on para-chlorobenzoic acid, resulting in the formation of a mono-sulphonic acid, $C_6H_4Cl(COOH)(SO_3H)$.—C. Liebermann has observed the formation of rosolic acid when phenol is treated with chloroform and sulphuric acid. This explains the ordinary formation of rosolic acid by heating phenol with oxalic acid.

STOCKHOLM

Academy of Sciences, April 12.—Dr. G. Lindström of Wisby was chosen Intendent of the Palæontological department of the Riks Museum. The following papers were communicated:—On the amplitude of the daily variation of temperature in Sweden, by Herr Rubenson.—On the varieties of Diabase and Gabbro in Sweden, by Herr A. E. Törnebohm.—Recherches sur un nouveau genre des Holothuries, by Docent Hj. Theel.—Contributions to a monograph of the Amphipoda, I.—The family Oxycephalidæ Spence Bate, by Docent C. Bovallius (this paper is written in English).—The land and fresh-water mollusca of Siberia, I., by Dr. Westerlund.—On the Dannemora iron-ore field, by Engineer A. E. Fahlcrantz.—Notes on the vertebrate fauna of North Bohus lan, by Herr C. Cederstrom.—Primæ linæ muscorum cognoscendorum, qui ad Caldas Brasiliæ sunt collecti, by J. Angstrom, M.D.—Herr Santesson was chosen president for the year now commenced. The retiring president, Herr Wœrn, gave an address on the manufacture of iron and steel in North America.

PARIS

Academy of Sciences, June 5.—Vice-Admiral Paris in the chair.—The following papers were read:—Astronomical researches (continued) by M. Le Verrier. He presented vol. xii. of the *Annales de l'Observatoire*, containing the tables of Jupiter and Saturn.—On the thermal formation of ozone, by M. Berthelot. He passed a current of oxygen through a tube, where it was acted on by the silent electric discharge, into a phial containing dilute arsenious acid. The transformation of the acid into arsenic acid was noted, and the heat liberated compared with that liberated in oxidation of arsenious acid by free oxygen. The heat liberated by change of ozone into ordinary oxygen is thus found to be + 14·8 cal., that is, − 14·8 in formation of ozone (or − 29·6 per atom). Ozone is thus a body formed with absorption of heat.—On the absorption of free nitrogen by organic matters at the ordinary temperature, by M. Berthelot. This occurs under influence of the silent discharge, and is well marked in the case of benzine; marsh-gas, acetylene, &c., also show it. Such phenomena must occur in thunder-storms, and have important physiological effects.—On the origin of organised ferments, by M. Pasteur. He controverts M. Frémy's results.—Influence of age of a tree on the average time of opening of its buds, by M. De Candolle. In certain species (horse-chestnut, *e.g.*) age has no influence; whereas, in others (such as the vine), it acts sometimes by retarding, sometimes by accelerating, the epoch in question.—On the displacement of lines in the spectra of stars, produced by their motion in space, by Mr. Huggins.—Examination of the possible mechanical action of light; study of Mr. Crookes's radioscope, by M. Ledieu (continued). He describes the experiments made by M. Fizeau, at his suggestion, with polarised light (the results were negative), proposes new experiments, and applies his theory in explanation of some celestial phenomena.—On the formation of an international committee for scientific exploration of the American isthmus with a view to making a canal, by M. de Lesseps.—M. Cosson presented a small apparatus called a central inflammatory obturator (for cartridges.)—Report on several memoirs of M. Allard on transparence of flames and of the atmosphere, and the visibility of lighthouses with flashing lights.—On the relations between the theory of numbers and the integral calculus, by M. Lucas.—On the photographic images obtained at the focus of astronomical telescopes, by M. Angot.—On the law of Dulong and Petit, by M. Terreil. He interprets it purely with reference to the laws of chemistry. The specific heat of bodies doubles when they cease to be gaseous.—On the irrigations in the south of France, and particularly in the department of the Bouches-du-Rhône, by M. Barral.—On the duration of tactile sensation, by M. Lalanne. Suppose a flexible body which will not hurt the skin by motion in contact with it, to be rapidly moved round the arm or leg. Analogously to the impression of a luminous circle before the eye when an incandescent stick is whirled rapidly, a continuous sensation should at a certain speed be produced, like that from pressure of a bracelet or ring. This is never experienced with less than ten turns per second. The least duration of tactile sensation observed was $\frac{1}{24}$ to $\frac{1}{35}$ of a second. It varies with individuals, and in different parts of the body.—On the galls of leaves of French vines, &c., by M. Boiteau. Notes on history of Phylloxera, especially the species *Phylloxera Acanthochermes*, Kollar, by M. Lichtenstein.—Memoir on the perturbing influence of neighbouring masses, on the form and disposition of crystals, by M. Brame.—On linear equations of the second order, by M. Pepin.—On the development in series of the functions Al(x), by M. Foubert.—On the number of points of contact of algebraic or transcendent curves of a system with an algebraic curve, by M. Fouret.—Improvement in Watts's indicator, by M. Mallet.—On the inconveniences arising from use of a cable of copper wire as conductor of a lightning-rod, by M. Francisque Michel. Such wires under electric action show, ere long, a series of fractures, which lessen considerably the conducting section.—On the influence of certain salts and of lime on saccharimetric observations, by M. Muntz.—On a derivative of acetylacetic ether, oxypyrotartaric acid, by M. Demarçay.—Combustion of organic matters under the double influence of heat and of a current of oxygen, by M. Loiseau.—Metallisation of organic substances, fitting them to receive galvanic deposits, by M. Cazeneuve.—Action of digitalis compared with that of biliary salts on the pulse, arterial tension, respiration, and temperature, by MM. Feltz and Ritter.—On the vascular apparatus of Trematoda, by M. Villot.

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THURSDAY, JUNE 29, 1876

GOVERNMENT AID TO SCIENTIFIC RESEARCH

WE publish below a correspondence which we cannot but regard with the greatest satisfaction; Government has at last seen it to be its duty to act upon the recommendation of the Duke of Devonshire's Commission, and make a substantial contribution towards the endowment of pure scientific research. We need scarcely remind our readers that from the first we have maintained that such endowment is the duty and interest of civilised states. But indeed it is long since the British Government practically acknowledged this to be the case; the grant of 1,000*l.* yearly to the Royal Society for purposes of research was first made twenty-five years ago. We hope the additional ...*l.*, making up 5,000*l.*, will be put to such excellent use that Government will not only renew the grant at the end of the five years, but see the necessity of increasing it to at least the sum suggested when the 1,000*l.* was first granted. No doubt the first to bring the duty of the State in respect to science prominently before the public in this country was the late Colonel Strange. He broached his scheme many years ago at the Norwich meeting of the British Association, and by his earnest and untiring advocacy he soon gained to his views most of the scientific men of the country, and Government became so impressed with the importance of the subject that the Science Commission was appointed in 1870. The substance of the various Reports of this Commission is familiar to our readers; the mass of evidence it has elicited has probably done more than anything else to enlighten the country and our Government as to the high importance and wide extent of scientific research. We can hardly expect Government to carry out all at once the recommendations of the Commissioners as to the extent to which unremunerative research should be assisted; but no doubt the 4,000*l.* which is to be annually entrusted to the administration of the Royal Society for the next five years, is the first, partly tentative step towards this. Then there were the strong words of Lord Derby, at Edinburgh, last December (see NATURE, vol. xiii. p. 141): "I think," he said, "that more liberal assistance in the prosecution of original scientific research is one of the recognised wants of our time." As the natural outcome of all this, and no doubt mainly as the result of the recommendations of the Science Commission, the Government has resolved to try what good results are likely to follow from a first and moderate endowment. We think we may safely prophecy that the result is likely in time to lead to the increase of the grant to at least the sum proposed to be entrusted to the Royal Society twenty-five years ago.

The difference between this new grant of 4,000*l.* and that of the old 1,000*l.*, should be noted. In the case of the latter the money had to be expended on instruments, &c., by the recipients, whereas in the case of the new grant the endowment may be personal; the grants may be made to individuals not merely to provide themselves with apparatus, but as a means of sustenance while prosecuting scientific researches incompatible with the pursuit of an ordinary means of livelihood. And here we should remark that we never advocated in these columns the wholesale selection of untried youths for the receipt of such endowments, nor is it meant thus to allocate the grant which has been made. The selection will be made from among those who by the work which they have already done have proved themselves capable of making a profitable use of the endowment.

Another point in the conditions attending the new grant we notice with pleasure, namely, the reconstruction of the Government Grant Committee of the Royal Society, so as to include the Presidents of the principal Scotch and Irish Societies, as well as those of the chief London scientific bodies. Thus the interests of Scotland and Ireland are as well cared for in this matter as those of England.

The Royal Society has now a great responsibility resting upon it. What with the annual 4,000*l.* from Government, in addition to the previous 1,000*l.*, and the 6,000*l.* which Mr. Jodrell has entrusted to its administration, it will have critical and important duties to science and to the country to perform. We are sure it will take every care so to allot these funds as to prove that it has only the interests of pure science at heart, and is quite competent to carry out the intentions of Government as well as of private donors.

The following is the correspondence in relation to the grant which has passed between Government and the Royal Society:—

LETTER TO THE PRESIDENT OF THE ROYAL SOCIETY.

Science and Art Department, South Kensington, S.W., April 29, 1876

SIR,—Her Majesty's Government have had under their consideration the question of giving some further aid to scientific research.

As you are aware a sum of 1,000*l.* is voted annually by Parliament "to enable the Royal Society to defray the expenses of scientific investigations considered by a Committee of the Society to be worthy of such aid." This Committee, called the Government Grant Committee, consists of the President and Council of the Royal Society and twenty-one other gentlemen of scientific eminence not members of the Council; and the Grant is expended in aiding investigators to provide themselves with apparatus and assistants, but never in personal payments to the investigators themselves.

It is proposed that this action of the State should be extended, and that further aid should be given to research by according permission to the Government Grant Committee to recommend in certain cases the payment of personal allowances to gentlemen during the time they are engaged in their investigations; that a sum of 5,000*l.*, including the above-mentioned 1,000*l.*, should be taken annually; that the Royal Society should be invited to aid Her Majesty's Government with their advice and assistance in its appropriation and expenditure, and as to the sums to be granted in each case, reporting annually to the Lords of the Committee of Council on Education on the progress made and the desirability or non-desirability of renewing the grant; and that this experiment should be tried for five years.

The Administration and expenditure of the grant, and accountability for it, should we consider be vested in the Science and Art Department of the Committee of Council on Education by which the vote will be taken; and all instruments purchased for investigations should be left in its charge when no longer required.

It would be advisable that the Presidents of the following Societies should be ex-officio members of the Government Grant Committee, viz. :—

The Royal Society of Edinburgh,
Royal Irish Academy,
Royal Astronomical Society,
Mathematical Society,
Chemical Society,
Linnean Society,
Zoological Society,
Geological Society,
Physical Society,
Institution of Civil Engineers,
Institute of Mechanical Engineers,
General Council of Medical Education and Registration of the United Kingdom.
Royal College of Physicians,
Royal College of Surgeons, and
British Association.

No definite rule can be laid down as to the amounts to be awarded in individual cases. These must depend upon various circumstances, especially on the amount of time which the investigator devotes to the inquiry.

There would be no objection to the application of some portion of this fund to the payment of such clerical assistance as may be found necessary.

I should feel obliged if you will consult the Council of the Royal Society on this scheme and inform me what is their opinion of it, and also give me the benefit of any suggestions as to modifications that may occur to them or to you.

I have the honour to remain, Sir,
Your obedient servant.
(Signed) RICHMOND AND GORDON

LETTER TO THE PRESIDENT OF THE ROYAL SOCIETY.

Science and Art Department, South Kensington, S.W., May 29, 1876

SIR,—In reference to our conversation on Monday last on the subject of the Duke of Richmond and Gordon's letter of April 29, I should feel obliged by your informing the Council of the Royal Society that the Lords of the Committee of Council on Education agree with you in thinking that, under the circumstances, it would perhaps be more advisable to leave the grant of 1,000*l.* exactly as at present. The conditions of the Lord President's letter would then apply only to the vote of 4,000*l.* Should the Council of the Royal Society concur in this view, we will communicate with the Treasury on the subject. The recommendations of the Royal Society with respect to the appropriation of the 4,000*l.* must, no doubt, be liable to revision by the Minister responsible to Parliament for its due administration, and of this responsibility he cannot divest himself. But the power is one, we believe, for the exercise of which there is never likely to be occasion. Should it, however, happen that the Committee of Council on Education found it inadvisable to act on all of the recommendations of the Royal Society, the best
course would probably be to give the Council an oppor-
items of revising them ; so that, if thought desirable, the
might be the grant, to which exception had been taken,
Society are llocated in some other way. If the Royal
or rejected as 'll desirous that the grant should be accepted
Council on Educwhole, the Lords of the Committee of
shall be done. But on will of course undertake that this
Council will agree thaty believe on consideration that the
have a mischievous effecch a course would be likely to
those recipients of grants wnnd entail great hardship on
attended their investigations, from the success that had
pected the continuance of their might naturally have ex-
As respects the reports of programts.
that the Council of the Royal Societys, My Lords believe
ment will naturally desire to have laid wellsee that Parlia-
them such a
report from those capable of giving an opinion, as will enable them to judge of the nature and amount of work being done, and the desirability, or otherwise, of continuing the grants. It is not asked that the report should be in any great detail ; as a rule it would be sufficient if it were of a general character, unless some of the subjects should from their special nature seem to require more precise information. The Lords of the Committee of Council on Education are fully aware of the great difficulties which surround the question of the direct encouragement of research and of the labour and responsibility that must necessarily be entailed on those who undertake to organise the experiment in this country. They therefore are glad to find that they may reckon on the cordial co-operation of the Royal Society, to whom they naturally first appealed to aid them in this matter.

I have the honour to be, Sir,
Your obedient Servant,
(Signed) SANDON

J. D. Hooker, Esq., C.B., M.D., &c.,
President of the Royal Society

LETTER TO LORD SANDON.

The Royal Society, Burlington House, W., June 2, 1876

My Lord,—With reference to your Lordship's letter to the President of the Royal Society dated May 29, I am to inform you that the President and Council of the Royal Society concur in the proposal therein contained, namely that, while the grant of 1,000*l.* should remain exactly as at present, a vote of 4,000*l.* should be taken on the conditions expressed in the Lord President's letter ; and that, in case it should happen that the Committee of Council on Education found it inadvisible to act on all the recommendations of the Royal Society, the Council of the Royal Society should have an opportunity of revising them, so that, if thought desirable, the items of the grant to which exception had been taken might be allocated in some other way.

I have the honour to be, my Lord,
Your obedient Servant,
(Signed) G. G. STOKES, Secretary, R.S.

The Lord Sandon, &c., &c., &c.

WALLACE'S GEOGRAPHICAL DISTRIBUTION OF ANIMALS[1]

The Geographical Distribution of Animals, with a Study of the Living and Extinct Faunas, as Elucidating the Past Changes of the Earth's Surface. By Alfred Russel Wallace. Two Vols. 8vo. (London : Macmillan and Co., 1876.)

II.

THE second part of his great work on Geographical Distribution Mr. Wallace devotes to the discussion of fossil animals. It might seem at first sight, as our author observes, rather out of place to begin the systematic treatment of this subject with extinct animals rather than with recent ones. But those who take the trouble to read these most interesting chapters will be speedily convinced to the contrary. Imperfect as is our knowledge of the geological past, enough has been already ascertained to enable some enchanting theories to be started which account to a greater or less extent for some of the most difficult problems of the present. As regards the comparatively recent extirpation of large and important forms which has taken place in Europe, in North America, and in South America alike since Post-Pliocene times, "it is clear," our author tells

[1] Continued from p. 168.

us, "that we are now in an altogether exceptional period of the earth's history," some idea of which it is very necessary to realise. "We live in an impoverished world, from which all the hugest and fiercest and strangest forms have recently disappeared." The cause of this great change over such a large part of the world's surface was, in Mr. Wallace's opinion, the "glacial epoch," which, according to Mr. Belt's theory, heaped up most of the water in the earth in mountains of ice round the two poles and left the great ocean beds comparatively dry. This, we are told, "must have acted in various ways to have produced alterations of the levels of the ocean as well as vast local flows, which would have combined with the excessive cold to destroy animal life" We are not sure that this is a *very* satisfactory explanation of the simultaneous disappearance of the great Irish Elk from Europe and the *Megatherium* from South America, but it is at all events *some* explanation of an obscure point, and deserves careful consideration So also do those few cases in which geological evidence is already sufficient to give us indications of the original birth-place of some of the mammalian types, and of the mode in which has come about their present state of distribution

The third section of Mr Wallace's great work, which we now enter upon, is, in fact, the most important of the whole, and that to which the previous chapters may be regarded purely as introductory Having shown us what the six great divisions of the earth's land-surface, zoologically considered, are, and how it may have come to pass that they are what they are, Mr. Wallace takes them one after the other in order, and gives us a separate memoir upon each of them, and their special zoological

FIG 3—A Brazilian Forest, with characteristic Mammalia

characteristics After a description of their territorial outlines, illustrated by hypsometrical maps in which the boundaries of the sub-regions are likewise indicated, general remarks are given upon their leading zoological features. The chief forms of mammals, birds, reptiles, batrachians, fishes, butterflies, beetles, and land-shells, which characterise them are pointed out. The Sub-regions into which they are divisible are then taken up and treated in greater detail, and the leading authorities from whose labours the necessary facts have become known to us are cited. At the end of each memoir "tables of distribution" are added, in which are given—first, a list of the families of the selected groups of animals represented within the Region, with an indication of their range, if any, beyond the Region, and secondly, a similar list of the genera of the terrestrial mammals and birds, with an indication of their ranges both within and beyond the Region Three or four plates, drawn by the late Mr J B. Zwecker, accompany each memoir.

These are intended to illustrate the physical aspect and zoological character of some well marked division of the region, and as only such species are figured as "do actually occur together in a state of nature," the scenes represented are "at all events not altogether impossible ones," which is more than many of our artistic friends can say of *their* productions! While we could have wished that Mr. Zwecker had resorted in some cases to the Zoological Society's Gardens rather than to previously published figures for the models of some of his animals, we must acknowledge generally the truthfulness of these illustrations and the faithful manner in which they have been executed At home alike in the tropics of the Oriental

and of the Neotropical regions, no one surely could have been more competent than Mr. Wallace to select the most characteristic forms for these plates, and we have great pleasure in reproducing some of them in these columns.

To those who know anything of Natural History the enormous labour involved in the compilation of these six memoirs will be at once apparent. The mass of details to be gone through in bringing together the most prominent known facts connected with the mammals, birds, reptiles, amphibians, fishes, butterflies, beetles, and land-shells of every different part of the world's surface, is a task that the boldest naturalist might well stand aghast at, especially when it is recollected that these details have to be picked out from several hundred different works and periodicals published in every quarter of the globe. That errors can be escaped in such a compilation even by a writer so cautious and so competent as Mr. Wallace is manifestly impossible. No intellect could expect to obtain personal acquaintance with more than a few selected branches of such a multifarious subject, and for the rest an author must trust to second-hand information. The selection of such second-hand information and its reduction into a uniform shape, is of itself a task of appalling magnitude, and we can only congratulate Mr. Wallace on having had strength and leisure to accomplish such a Herculean labour.

The fourth and last part of Mr. Wallace's work contains, as we have already explained, a review of the distribution of the different groups of animals which he has selected for the illustration of geographical distribution arranged in systematic order. The families are taken up

FIG. 4.—A Forest Scene on the Upper Amazon, with some Characteristic Birds.

one after another, the principal genera are mentioned, and notes are given on the more remarkable species. At the end of each order is appended a series of remarks on the general distribution of the whole group. This is in fact the storehouse of information from which the essays on the six zoological regions have been compiled, and should in strictness have preceded the third section of the work instead of following it. The author wisely recommends persons not well versed in zoology to read the more important parts of it—especially the observations at the close of each order—before they begin Part III. As regards this systematic treatise the observations which we have already made on the difficulties to be mastered in the compilation of the memoirs relating to the six geographical regions are still more applicable. It would be easy to point out many passages in which Mr. Wallace has not in our opinion made the most judicious choice of authorities. Errors of detail are, however, as has been already stated, unavoidable in a work of this extent—happy is he who makes fewest of them! Even in the case of some of the largest and most prominent families of the great class of mammals, naturalists are by no means yet agreed as to the number of species and genera that should be admitted. For example, Mr. Wallace, we observe, assigns "four, or perhaps five" rhinoceroses to Africa, but Prof. Flower—one of the highest living authorities on this class of animals, in a recent paper read before the Zoological Society of London—could only recognise *two*. Mr. Wallace admits the validity of *Elasmognathus* of

Gill as a genus of Tapirs, and adopts Dr. Gray's multitudinous division of the well-defined and eminently natural group of Eared Seals (*Otaria*). Many naturalists would hesitate before following Mr. Gill and Dr. Gray as authorities on these (or perhaps we may add on many other) subjects. But such and similar errors on questions of detail do not, we believe, affect the validity of Mr. Wallace's general conclusions. After the miserable stuff usually thrust before us in even the best and most recent treatises on geography, when the question of distribution comes to be touched upon, it is truly refreshing to turn to Mr. Wallace's broad and enlightened views on this subject. Future compilers of geographical manuals will have an easy task when they come to this most important but hitherto most ill-used part of their work, if they will only cast aside all that they have previously written, and borrow freely from the volume now before us.

Mr. Wallace has already registered many claims on the gratitude of naturalists present and future. In their interest he has explored the tropics of the east and the wildernesses of the west, and has brought home numberless novelties. He has written one of the best and most instructive books of naturalists' travels ever yet issued. He was, as is well known, the joint inventor with Mr. Darwin of the theory of "Natural Selection." But beyond all these scientific feats—and they are no mean ones—he has accomplished a task that will extend his fame even more widely amongst those who love science, as the author of the first sound treatise on zoological geography.

TWINING'S "SCIENCE MADE EASY"

Science Made Easy: a Series of Familiar Lectures on the Elements of Scientific Knowledge most Required in Daily Life. By Thomas Twining. (London: Chapman and Hall, 1876.)

THESE thin clearly printed quartos represent a remarkable experiment; an attempt to diffuse good teaching without good teachers, and to reproduce first-rate popular lectures without the need of multiplying skilled lecturers to deliver them. The author, Mr. Twining, constructed in 1856 an Economic Museum at Twickenham, which exhibited illustrations of scientific knowledge as applicable to the concerns of daily life. After fifteen years of continuous improvement this collection was destroyed by fire; but the experience gained in working it strongly impressed upon its author the conviction that the level of popular culture in this country is below the point at which intelligent appreciation of the simplest scientific object becomes possible; since his fine museum, with its methodical classification, its careful explanatory labelling, and the oral instruction of its active curator, failed to convey knowledge to the mass of visitors, to whom the very alphabet of science was unknown, and whose minds were untrained to the reception of the simplest truths. It is a bold thing for one man to enter on the task of educating a people; but Mr. Twining's enthusiasm was equal to the attempt. Precluded himself from lecturing, he prepared carefully-written lectures, founded on his Twickenham experience, and entrusted them to others to deliver. The swimming bath of East Lambeth, dry and unused in the winter, was fitted up as a lecture-room, and a course of five lectures was there delivered to attentive audiences of more than a thousand persons. Demands for their repetition arose from all parts of London; and during the last nine seasons they have been delivered in various mission-rooms, institutes, and clubs of the working-classes to crowded and eager hearers. Uneducated learners, however respectfully attentive, yet carrying away from a lecture ideas crude and disjointed, may lapse within a few days into their original ignorance; Mr. Twining therefore began early to test his audiences by a system of examinations, so modified as to meet the inexperience of candidates and the elementary character of the teaching. Examination programmes were issued, containing a full set of possible questions on the course, from ten to fourteen being allotted to each lecture, with the understanding that from every one of these groups two questions would be selected by the examiner; while a preliminary examination "of a friendly kind" struck off all who were clearly incapable of presenting themselves with any prospect of success. Under these limitations we are told that a large number of candidates have obtained prizes and certificates at successive examinations, their papers showing that they had grasped and could reproduce intelligently a fair amount of the teaching which they had received.

Mr. Twining thinks that what has been done in London may easily be done elsewhere; he therefore prints his lectures, and prefaces them with minute instructions for the guidance of such amateurs as may wish to organise and carry out the course. In its delivery two persons are necessary, a "reader" and a "demonstrator." The reader must be a good elocutionist, and need be nothing more; need know nothing of science in general, nothing of the particular science on which he is discoursing. If he is clever enough to introduce here and there a happy local *à propos*, so much the better; but he is a mere vehicle for the transmission of the matter contained in his text, and is not required to do more than utter it. The demonstrator must know something of science, and have some practice in manipulation; but the simplicity of the experiments and the fulness of the printed directions reduce this necessity to a minimum, so that the author proposes to himself as suitable interpreters in a country town the national schoolmaster as reader, and the doctor or dispensing chemist as demonstrator. Reference numbers, dotted lines, and other devices, indicate the relative duties of the two performers, who cannot of course expect to work smoothly and in concert without repeated and laborious rehearsals.

The ordinary science teacher, luxuriating in abundant time, in ample apparatus, and in educated hearers, might be tempted to speak unfavourably of the lectures themselves, as too condensed for practical usefulness. He might say, and say truly, that the matter contained in the three lectures on Mechanical Physics could scarcely, by a master teaching boys, be included in the five-and-twenty lectures of an ordinary school term; that the two lectures on Chemistry are overgrown object lessons; that no one of the seventeen topics treated in the single lecture on Chemical Physics would demand less than an hour's careful teaching in a class-room; and that the "questionary," or examination programme, represents pure and simple cram. But such criticism would be wholly unfair applied to Mr. Twining's enterprise, as overlooking its

condition and its aim: the condition, an audience of weary working-men, with little time to give, and who reject all instruction which is not easily grasped and enlivened by amusing spectacles: the aim, to communicate entertaining knowledge in a utilitarian spirit, to open a glimpse of intellectual enjoyment such as may at the same time bear practically on the comfort and happiness of daily life. In the experience necessary for such a taste Mr. Twining probably stands alone, and in reviewing the forms his efforts have taken we may fairly bow to the judgment which shaped them.

But the main objection to this curious and novel system will occur to everyone. Is it possible that any man uttering the knowledge and the thoughts of others on a subject with which he is quite unfamiliar can import into his task the enthusiasm necessary to kindle and inform an audience? A purchased sermon read from a pulpit never yet edified anyone; will it be more inspiring to receive scientific truth from the lips of a man who articulates by rote instead of teaching from that lofty standpoint of superior knowledge which converts hearers into disciples? Mr. Twining speaks gratefully of the admirable readers he has been fortunate enough to find in London. They were probably not mere elocutionists, but possessed of dramatic minds, and able to generate at will enthusiasm in a noble though unfamiliar subject, and their like will not be met with every day. Mr. Twining shows his uneasiness on this point by his strong injunctions to careful practice on the part both of reader and demonstrator, and whoever attempts to carry out the scheme will have to lay special stress on this. Nor can we omit to mention the subject of expense. The apparatus necessary *only* for the six lectures before us costs, exclusive of plans and diagrams, from 44*l.* to 48*l.* 10*s.* A club, society, or institute, including dexterous workmen amongst its members, could probably obtain all that is wanted at half this price, but in many places the difficulty of meeting the expense might turn the scale against the introduction of the lectures.

These difficulties have, no doubt, been well considered by the author of the scheme, and are thought by him to be not insurmountable. We most sincerely hope that it may be found so. His enterprise will be watched with no slight interest by all who feel that the spread of scientific knowledge among the operative classes is a pressing national necessity, and that one who devotes to it, as Mr. Twining has done, experience, thought, and toil, deserves the gratitude and the help of his countrymen.

W. T.

OUR BOOK SHELF

Life with the Hamran Arabs. An account of a Sporting Tour of some Officers of the Guards in the Soudan during the winter of 1874-5. By Arthur R. Myers, Surgeon, Coldstream Guards. With Photographs. (London: Smith, Elder, and Co., 1876.)

THE sporting tour of which Mr. Myers gives the narrative in this volume was made at the same time as that described by the Earl of Mayo in the work which we recently noticed. Indeed the two parties started together, and their work lay in regions not far distant from each other. Mr. Myers and his party were much more fortunate than the Earl's party. They did not meet with so many hindrances, and were much more fortunate in the number and variety of animals that came in the way of their rifles. The region to which Mr. Myers's work refers is on the borders of Abyssinia and Egypt, and has been already made familiar to English readers by Sir Samuel Baker in his "Nile Tributaries." Mr. Myers simply pretends to tell of his sporting adventures, and therefore we have no reason to complain if he adds little to our knowledge of the country of the Hamran Arabs. He writes in an unpretentious style, and his work will be found interesting by the general reader, and specially so by those who love sport. It contains photographs of some of the trophies brought home, arranged by Ward and Co.; they give a good idea of the variety of animal life to be met with in this part of the Soudan.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Decrease of the Polynesians [1]

I BELIEVE there are some errors popularly received respecting the rapidity with which the inhabitants of Polynesia, as a whole, are disappearing before an advancing civilisation. I wish to make a few statements on this subject in connection with a review of Miss Bird's book on "The Hawaiian Archipelago," which appeared in NATURE, vol. xi. p. 322.

The primary source of error is the excessively high estimates as to the population of different islands in Polynesia made by early visitors and residents. In most of the islands the people live chiefly, or entirely on the coasts; whereas, in the estimates, allowance is made for a proportionate population in the interior.

Another error, I believe, is the supposition that the decrease of the people is entirely (or almost entirely) owing to their contact with foreigners. From personal knowledge of Polynesia I feel convinced that the people were rapidly decreasing before their intercourse with civilised races commenced.

It is also a mistake to suppose that decrease is by any means universal at the present time. While in some islands the decrease of the natives has been accelerated since they have come into contact with modern civilisation and its attendant evils, in other islands the previous decrease has been greatly retarded, or even changed into an increase, by the beneficial influences of a Christian civilisation. This change has been brought about by such causes as the following:—The partial or complete cessation of wars; the discontinuance of human sacrifices (in some islands the cessation of cannibalism may be added); the cessation of infanticide; the greater respect paid to women, which leads to their release from some of the hard work which, in heathen times (in some portions of the Pacific) fell almost entirely to their share, and the consequent increase of living and healthy progeny; the increased care taken of infants and aged people, and the general progress of industry resulting from more settled habits, which leads to a more regular supply of food.

As an example, in proof of the correctness of my statements I will cite the Samoan Islands. In the "Encyclopædia Britannica" (eighth edition) we read:—"The population of Samoa

[1] I wrote this paper some months ago, intending to send it for publication in NATURE, but I afterwards determined on withholding it for the present, hoping at some future time to discuss in a more systematic and thorough manner this subject, together with some other questions bearing on the ethnology and anthropology of Polynesia. I am now, however, induced, by the reference in Prof. Rolleston's address before the British Association at Bristol, to publish it as it was first written, hoping it may prove a small contribution towards a correct understanding of this subject.

I take this opportunity to thank Dr. Rolleston for putting in its true light the relation which the work of missionaries bears to the decrease of Aboriginal populations. It is high time that the ignorance, prejudice, and narrowness manifested by many literary and scientific men gave place to a broad, common sense, and enlightened view of the matter. Missionaries are sometimes represented as if they were the actual *destroyers* of the weaker races; a view somewhat *smartly* set forth in one of Mr. Bernard Quaritch's scientific book catalogues (No. 294, Jan. 1875) in the following words:—"The missionary is a grand and striking figure in the history of the world. Robed in black, and bearing the *Word of Life*, he moves among the weaker races of mankind; around his path they sicken and perish, and countless nations of men are swept away." In Polynesia, the agents of the London Missionary Society, at least, usually dress in *white*, and not in *black*, and I imagine most sensible missionaries who live in the tropics, do as we do in this respect. But whether we wear the ominous black, or adopt the more hopeful (or comfortable) white, I fancy Mr. Quaritch is guilty of what the logicians call an *ignoratio elenchi*.

S. J. W.

Samoa, Dec. 30, 1875

has been variously estimated from as many as 160,000 to as few as 38,000. The Rev. J. Williams estimated them at the former number in 1830, and Capt. Erskine, in 1854, at the latter; but by the missionaries (*Samoan Reporter*, 1845), the population was reckoned at from 50,000 to 60,000. At present the Samoan nation does not probably exceed 40,000 souls" (vol. xviii. p. 278. See also vol. xvi. p. 88).

In 1853 the first census of the population of these islands was taken, and it was then found that the natives numbered 33,901. Thus, according to the Rev. J. Williams's estimate, there was a decrease of 126,099 in twenty-three years, or 5,482 per annum! According to the lowest estimate of the missionaries in 1845, there was a decrease of 16,099 in eight years, or 2,012 per annum! Capt. Erskine's more moderate estimate was 4,099 above the actual number ascertained by census the year before he made it.

In 1863 a second census of the population was taken, and the natives then numbered 35,097, showing an increase of 1,196 in ten years, or $119\frac{6}{10}$ per annum.

In 1874 another general census of Samoa was taken, and the entire native population was found to be 34,265, showing a decrease of 832 in the eleven years since 1863, but still giving an increase, in the twenty-one years since 1853, of 364: the decrease during the shorter period averaging $75\frac{7}{11}$ per annum, while the increase during the longer period averages $17\frac{1}{3}$ per annum. This difference is easily accounted for. During the eleven years which intervened between the second census and that recently taken, there was a civil war in the principal islands which lasted more than four years, in consequence of which the usual death-rate was largely increased. This was not merely owing to the actual number of people killed in fighting, but chiefly to privation and suffering in those districts where the fighting took place. The census shows a decrease on the different islands in proportion to the amount of damage done, and the consequent privations suffered by the people. Thus Upolu, which was the principal seat of the war, suffered very severely; and here there was a decrease of 988 in a population of 17,556, or more than 5 per cent. Savaii, which suffered comparatively little, shows a decrease of 140 in a population of 12 670—slightly over 1 per cent. On the other hand, the island of Tutuila, which was not involved in the war, shows an *increase* of 296, or more than 8 per cent. in the eleven years: the population in 1863 being 3,450, while in 1874 it amounted to 3,746.

In one part of Upolu, where a register of births and deaths was kept for several years previous to the above-mentioned war, there was an annual excess in the number of births over the deaths, averaging from 1 to 2 per cent. I believe the decrease in the aggregate population during the eleven years is entirely owing to the war.

The population of the small island of Niuē (Savage Island) was counted in 1859 and found to number 4,300. It was counted again in 1864, and found to number 5,010, showing an increase of 710 in five years, or more than 3 per cent. per annum. In 1868 the population was again numbered, and found to amount to 5,060, showing an increase of fifty only in four years. But at the latter date many of the natives were away as voluntary immigrant labourers in other islands—seventy-five being in Samoa—and many others were sailors on board vessels: hence that does not represent the actual increase. I know many other islands in Polynesia where there is a steady increase in the population year by year, since the abolition of paganism.

But notwithstanding these facts, which give some hope for the Polynesians, I fear the balance is against them in the aggregate, and that the general tendency is towards a more or less rapid decrease which—unless some measures for their conservation are found—will greatly diminish, if not destroy them. The causes which produce this tendency are, *first*, those epidemic diseases which commit such fearful havoc in localities to which they are newly introduced. Some of them, such as influenza and measles, are comparatively harmless in countries where they have long been prevalent. But they are terribly fatal in a new country, as has lately been seen in Fiji. This excessive mortality is not, I believe, owing to the want of stamina in the constitutions of the natives; but may be accounted for by their mode of life, and by the fact that the inhabitants of entire villages are stricken together, leaving none in health to procure food for, and attend to, the sick.

But fearful as the effects of these epidemic diseases are, they do not recur, and, in my opinion, there are other causes which, in the end, prove themselves far more destructive. These are constantly working, and are every day working with augmented power; and these the Polynesians owe entirely to their intercourse with foreigners. They are *ardent spirits* and *syphilis*. In the case of the Hawaiian Islands, *leprosy* may be added; for in that archipelago these three scourges are working with fearful effect, and they bid fair to sweep off the greater part of the natives. But those islands must not be taken as fairly representative of the state of Polynesia as a whole. In many islands the drinking of foreign spirits is almost unknown, and in many more syphilis is rarely if ever met with.

The question may be asked, What possible remedies can be suggested which may, by moderating, or removing, the causes of decrease, help in the conservation of the Polynesians? The only possible remedies which at present occur to me are: (1) Strict quarantine regulations wherever there is a government by which they can be enforced. (2) A heavy duty (which would be, practically, prohibitory) on the deleterious kinds of spirits commonly imported into the islands and vended to the natives.

The introduction of measles into Fiji since the establishment of British rule there does not speak very strongly in favour of the efficacy of the first remedy. But there surely must have been some serious oversight or neglect on the part of medical officers, when infected persons were permitted to land on those islands from a British man-of-war, and such oversight or neglect ought not to be repeated elsewhere.

It would be a blessing if some measures could be taken to protect the Polynesians against one of their worst enemies—ardent spirits. It is notorious that an immense quantity of a noxious kind of spirit is constantly imported into some of the islands and sold to the natives. The taste for this deleterious drink is increasing, and likely still to increase. If low traders will continue to vend such a vile compound, without regard to the amount of human misery, or even loss of life, which may result therefrom, it appears to me that all respectable merchants who do business in Polynesia should set themselves against it and keep their hands clean from the traffic.

Samoa, South Pacific S. J. WHITMEE

Wind Driftage

IN the interesting narrative of the cruise of the *Challenger* that appeared in NATURE (vol. xiv. p. 93), the wind-formed rocks and drift of the Bermudas are referred to. This probably will call attention to the much-neglected subject of wind driftage; but I sincerely trust Prof. Thomson and his Colleague will discard such an ill-advised name as "sand-glaciers" for the inundations of "Æolian" or "blowing sands." The term glacier belongs to ice; beside, these sand-streams do not act like glaciers, their advance being more similar to that of a lava flow.

Somewhat similar sands occur in Australia, and were described years ago under the name of "Æolian drift," by an officer of the Royal Engineers (whose name I now forget), those in the vicinity of Melbourne Bay being remarkable for containing regular strata of empty bottles. In Kutch there are extensive wind-formed rocks, in some, such as Meeta and Kara, the cement being principally salt. On the coast of Ireland travelling sands can be studied on a small scale. At Bundoran, the late Lord Palmerston stopped the Æolian drift from travelling by planting it with the Austrian pine; on the west coast in places considerable encroachments take place, one of the most conspicuous now in progress occurring to the east of Broad Haven, co. Mayo. Here, a few years ago, the "bent," or grass on a large accumulation of sand was cut by the natives, and the sand began to travel eastward. Now it has destroyed several hundred acres of tillage land and driven the inhabitants before it over the brow of the hill into a boggy valley. G. HENRY KINAHAN

Wexford, June 10

Freezing Phenomenon

PROBABLY the following statement may be of use, probably also it is nothing new, but in the faint hope of its being a mite of value, I send it.

In a wash-hand basin, placed in an out-house where fine dust fell on the surface of the water, I noticed this last winter, that there was a thin sheet of ice atop, and that the dust had fallen to the bottom of the basin, and there was arranged in precisely the same patterns as were to be seen in the hoar-frost on the panes of glass of some neighbouring hot-beds.

This would seem to show that, in freezing, water goes through a series of fantastic movements.

Could such motions be at all comparable with the changes that the particles of iron go through from cold, and occasionally

rendering a supposed good piece of metal quite brittle and dangerous if trusted to do its ordinary duty, such accidents happening as a rule in cold weather?

June 24 WILMOT H. T. POWER

Sagacity in Cats

THE following facts are curious: I should be glad if any of your readers can inform me whether anything of the kind has been already noticed. I have a cat of half-Persian breed; she is about eight years old, and has always been remarkable for her aversion to strangers, more especially to children. If children have at any time come into the house where she was, she has invariably decamped and secreted herself. She never could bear to be handled or pulled about (which so many cats seem to enjoy) by anyone but by her master.

During the present year this cat has remained in Scotland; a few weeks ago my little boy went to reside in the house where the cat is at present. This boy is just at that age when children delight in pulling about everything they can get hold of: naturally a cat was a perfect godsend to him. After a few days the cat was seen to smell the child repeatedly; she seemed to be satisfied of his relationship, and since that time she follows him about the house (a thing which she never did to anyone but her master), rubs herself against him, and allows him to pull her tail and ears and draw her about by the legs.

Owens College, June 22 M. M. PATTISON MUIR

OUR ASTRONOMICAL COLUMN

LE VERRIER'S TABLES OF SATURN.—Vol. xii. of the *Annales* of the Observatory of Paris, containing, in addition to his Tables of Jupiter, the more extensive Tables of Saturn, was presented by M. Le Verrier to the Academy of Sciences on the 5th of the present month. To insure, as M. Le Verrier has explained, their accurate and convenient application, the Tables of Saturn occupy two-thirds more space than those of Jupiter, or 278 and 170 pages respectively, though their general form and arrangement appears to be the same, and as those who have seen the Tables of Jupiter will be aware, is materially different from the arrangement of the Tables of Mercury to Mars inclusive. The tables of Saturn represent exactly the observations from Bradley to the present day.

M. Le Verrier again mentioned that his theories of Uranus and Neptune were complete, and susceptible of being extended to an indefinite number of years. The comparison of the theories with observation is already sufficiently advanced to enable him to pronounce upon their satisfactory agreement.

36 OPHIUCHI.—It appears to have been somewhat hastily concluded that this star, so remarkable for its identity of proper motion, both as regards amount and direction with the distant 30 Scorpii, is also a binary system. So far the measures by no means bear out this inference, and unless they are affected with unusual errors it is not easy to explain them. For comparison the following may be selected:—

Herschel and South	1822·52	Pos.	227·4	Dis.	5·55
Herschel	1835·19	,,	223·5		4·88
Dawes	1841·59	,,	219·3		4·78
Jacob	1846·21	,,	216·2		4·66
,, ...	1850·62	,,	214·9		4·49
,, ...	1854·07	,,	214·4		4·13
Barclay	1871·51	,,	210 6		5·01

It might be supposed from these measures, that while the angle has been slowly retrograding between the years 1822 and 1871, the distance had diminished until 1854, and is now on the increase, but on projecting the measures it will be seen that this would indicate a motion of one star in a curve convex towards the other. If there are material errors of observation, the real motion of the companion may be rectilinear, or the change in angle and distance may be caused by a slight difference in the proper motions of the stars. Further careful measures, however, are yet required before any safe inference can be made, and more especially in latitudes where the star r... to a greater altitude than in this country. Capt. Jacob's comparatively small distance in 1854 is not supported by the meridian observations at Greenwich, Oxford, and Washington, from which we might conclude, it was nearly one second greater than his result, but meridian observations are not always reliable for such delicate comparisons, and besides it seems hardly probable that so practised and excellent an astrometer as Capt. Jacob would be in error 1″ in the distance of so easy a star, favoured as he was by his positions at Poona and Madras; Secchi also is confirmatory. The statement of Chr. Mayer that the companion was 13″·2 due S. of the principal star, or on an angle of 180° (not 360° as given by Smyth in the "Cycle"), does not assist an explanation.

NOVA OPHIUCHI, 1848.—This star has been a difficult object for the generality of telescopes during the last few years. In 1856 it had descended to the eleventh magnitude; ten years later it was a faint twelfth, and in 1874-75 not higher than thirteen in the scale in ordinary... Herr Julius Schmidt carefully examined the vicinity at Athens in August 1867, fixing the positions of the small stars near the variable, which were discernible in the 6-feet refractor of that observatory. These places are here brought up to the beginning of the present year, with the view to facilitate the recognition of the object which became so suddenly conspicuous to the naked eye at the end of April 1848. The magnitudes are Schmidt's.

No of Star.	Magnitude.	R A. h. m. s.	N P.D. ° ′ ″	
1	11	16 52 3·9	102 46 1	
2	13	16 52 28·7	102 44 4	
Nova	Var.	16 52 33·1	102 42 3	From the first Radcliffe Catalogue.
3	11	16 52 55·4	102 49 12	
4	11	16 53 2 5	102 34 1	
5	10·11	16 54 19·8	102 49 6	

The ninth magnitude, Lalande 30853, R.A. 1876·0, 16h. 52m. 18 5s. N.P.D. 103° 0′ 24″, may be used to identify the variable which it precedes 14 6 seconds, and is 18′ 21″ more southerly. Schmidt thought there might be a star 13·14, following the variable 5s. or 6s. His stars (1) and (3) had these position-angles and distances, while *Nova* was still visible without the telescope in 1848.

(1) Position ...	249·4	Distance ...	475″·4
(3) ,, ..	144·5	,, ...	530·8

The star (2) was repeatedly measured in position and distance in 1848, with the 15-inch refractor at Harvard College by the Bonds, with the view to discover if there were appreciable parallax in the variable; it is called a fifteenth magnitude in the Harvard scale, and by a mean of ten nights' measures its position was 212°·11, and distance 115″·65 for 1848·52.

STEPHAN'S COMET, 1867 (I).—This comet, for which Mr. Searle found an elliptic orbit, period 33·62 years, or almost precisely that of the comet of the November meteors, and which was shown some years since to make a very near approach to the orbit of the planet Uranus, appears also to pass at a short distance from that of Mars. In heliocentric ecliptical longitude 81° 53′, and latitude + 1° 5′, with true anomaly, 6° 10′, the distance between the two orbits is only 0·0207, thus affording a similar instance of close approximation to this planet which Dr. Brünnow found to take place in the case of De Vico's comet of short-period. It is singular that a comet's orbit should lie so very near to the orbits of two of the planets, in one instance near its perihelion, and in the other not far from aphelion.

THE COMET OF 1698.—In the first orbit of this comet in the last *Astronomical Column*, the perihelion passage should be dated *October*.

THE SATELLITE OF VENUS[1]

AN indirect result of the recent Transit of Venus has been the revival of a nearly forgotten but not uninteresting speculation as to the possible existence of a satellite accompanying her. Nothing of the kind was observed on the late occasion, but the planet's path was so far from central that an attendant might readily have remained outside the solar disc; and therefore, though the negative evidence, if it had required additional strength, would have received it from this non-appearance, it would not have been rendered absolutely conclusive on that ground alone; and, so far as the Transit is concerned, there is still room for an essay like that before us, which, previous in composition though subsequently published, advocates the affirmative opinion. That opinion, after so many years of additional observation since Lambert's memoir in 1777, is not likely to find favour with astronomers now, and certainly will not be established by the present treatise. It is an unpleasant task to express any other than a favourable estimate of any work undertaken with a view to enlarge the boundary of knowledge; but in the present instance it is unavoidable. There is, indeed, a very considerable accumulation of historical matter, and there are some pleasant anecdotes, and a few valuable and little known facts; but the materials of some portions at least are neither complete nor accurate; the pretermission of recent discoveries especially spectroscopic is sometimes simply unaccountable; and the hypotheses occasionally partake of an extravagance that outstrips all probability. The subject is, however, as has been remarked, not devoid of some interest, nor, to say the truth, disentangled from some perplexity of an obstinate character; and it is worthy of a more satisfactory elucidation, which might be comprised in a narrow compass, as its literature is not extensive. A few remarks only can be attempted here.

That something strongly resembling a satellite has been occasionally seen near Venus, especially about the middle of the last century, is beyond a doubt. It is equally certain, and familiar to all experienced observers, that reflected images, or technically "ghosts," may, under certain circumstances, be formed in the eye-piece of the telescope, and might be the means of causing deception: and the whole matter is reduced to the simple inquiry, whether all the recorded instances admit of this easy explanation; though, if they do not, it must be remembered that the existence of a satellite would not necessarily follow.

The Abbot Hell, who published an elaborate dissertation on the subject in the appendix to the Vienna Astronomical Ephemerides for 1766, seems to have been the first to study systematically the formation of telescopic ghosts. The Vienna Observatory was possessed in those days of two good English telescopes, left to it in 1757 by Cardinal de Trautson; a 2 ft. Gregorian, and a $4\frac{1}{2}$ ft. Newtonian. About December in that year, the Abbot, examining Venus with the former instrument and a power of 70 or 80, perceived a star of an ill defined aspect near it like a little comet, but as it was invisible both in that Newtonian and in another of the same construction of 4 ft., he referred it to a reflection from the interior of the tube. In March 1758, Venus being at her greatest elongation, the illusion returned, on which he blackened the tube, and for some days did not see it again; but when at length it reappeared, on moving his eye very gently towards the eye-piece he found it change into a perfect image of a satellite with the phase of the primary. Beyond the limit of barely half a line either way from this position, it was invisible. When Venus occupied the centre of the field, this "spectrum," as he calls it, was near the edge; as he moved his eye round, or up and down, the image moved the same way, generally disappearing in the neighbourhood of the planet. A set of experiments instituted in consequence satisfied him that this image was formed by rays reflected first from the convexity of the "pupil" (cornea), and a second time from the concave face of the meniscus lens which in this case formed the eye-glass, though it would be shown by any eye-piece possessing a surface concave towards the retina. Cases were even possible, but difficult in management, when an image might be seen, though the object was not in the field; but this was formed by rays passing outside the telescope, and the ghost would be inverted and of much smaller dimensions. The magnitude of the image would depend on the proportion of curvature of the reflecting surfaces. This being once understood, the Abbot found that he could always produce, for himself or others, a spurious satellite of Venus, or Mars, or Jupiter, under the following essential conditions:—That the power should not be less than 50 or 80, or the image would be too minute to be visible, or would only resemble a small star;—that the eye must be placed at a definite distance from the eye-glass, and be moved most deliberately and cautiously backwards and forwards to find that point, the limit of visibility being sometimes only a quarter of a line either way;—and that the eye must be a little on one side of the optical axis, or the image will coincide with its primary. And it becomes readily intelligible why an observer, ignorant of these conditions, may never be able to recover an image which he had once accidentally seen. Thus far, in substance, the astronomer of Vienna, who certainly deserves credit for his ingenious and careful investigation. His reasoning is, nevertheless, a curious and instructive exemplification of the way in which a preconceived opinion may block up the mental view, and prevent a sound argument from being carried out to its legitimate consequences.

We are now in a position to examine how far this criterion is applicable to the recorded phenomena. Of these, Dr. Schorr has enumerated sixteen, in a table taken apparently from Lambert, but with the addition of an observation by Andreas Meier (Mayer). Hell had given three from Fontana, but Lambert seems to have thought one only of any consequence, and even this may well be omitted, leaving the following for our consideration.

The name of Cassini at the head of them at once commands attention, but there is nothing in his two observations in 1672 and 1686 that does not lend itself to Father Hell's hypothesis, excepting the care and experience of such an observer, who must have been familiar with every telescopic defect. The observation of Meier, which seems to have lain unnoticed in the *Astron. Jahrbuch*, 1788, till brought forward by Schorr, is on that account worthy of being cited in full. "1759, May 20, about 8h. 45m. 50s., I saw above Venus a little globe of far inferior brightness, about $1\frac{1}{2}$ diam. of Venus from herself. Future observations will show whether this little globe was an optical appearance or the satellite of Venus. The observation was made with a Gregorian telescope of thirty inches focus. It continued for half an hour, and the position of the little globe with regard to Venus remained the same, although the direction of the telescope had been changed." During so lengthened an observation it seems natural to suppose that the eye must have been repeatedly removed and replaced, which could not have occurred without the detection of an optical illusion.

In 1761, when the expected transit drew attention to Venus, Montaigne, at Limoges, was persuaded to undertake the inquiry, though he had little faith in the existence of the satellite, and was not greatly disposed to enter upon an examination in which so many great men had failed. However, on May 3 he saw a small crescent

[1] "Venusmond," &c., von Dr. F. Schorr. Braunschweig, 1875. pp.

20′ from Venus; it is expressly stated that the observation was repeated several times, and that after all he was not certain if it was not a small star; which, with a power of between forty and fifty, was not surprising. The next evening and on the 7th and 11th it was again seen, rather more distant, and each time in an altered position, but with the same phase as its primary; and on the 7th it was seen, and even much more distinctly, when Venus was not in the field. The improbability is obvious of such persistency in an illusion so readily detected. The cause may indeed have lain in the object-glass; such telescopes have been known. Wargentin, at Stockholm in the same year, found that his instrument produced a deception from this cause; and the 6-inch Cauchoix achromatic at Rome showed minute comites to bright stars a little too frequently for the credit of those who trusted it. Montaigne's changed position-angles may be thought to indicate this cause of error, as his 9-ft. refractor probably admitted of rotation in its bearings, but it is a singular coincidence that these changes should all have been in the direction of orbital revolution, and still more, in such proportions as to be reconcilable with Lambert's calculated period of about eleven days; and it is quite unintelligible that he should not have subsequently detected the fault in his telescope, as from his estimation of angles and distances he was evidently not a novice in observation. Three years later, in 1764, Rodkier, in Copenhagen, saw such an appearance on two evenings with a power of thirty-eight on a 9½ ft. refractor; on the latter occasion with a second telescope also. There is little in this to contravene the Vienna theory, especially as this second telescope had a coloured meniscus eye-glass, and he failed in finding it with two other instruments: but it is more remarkable that on two evenings a week later the same telescope told the same tale to four different observers, one of whom was Horrebow, the Professor of Astronomy, and who, we are assured, satisfied themselves by several experiments before the second observation that it was not a deception. That the necessary conditions for its being such could have been maintained before so many eyes, is, notwithstanding its admitted pale and uncertain aspect, what could not possibly have been anticipated. But we have not yet done with this temporary outbreak, so to speak, of visibility. Before this month of March was ended, Montbarron at Auxerre, far removed from all possibility of communication, and with a very different kind of telescope, a Gregorian reflector of thirty-two inches, which of course was fixed as to its optical axis, perceived on three separate evenings, at different position-angles, something which, though it had no distinguishable phasis, was evidently not a star, and which he never could find again.

There remains still the observation of the celebrated optician Short. It is indeed chronologically misplaced here, but has been intentionally deferred as affording the strongest point in the whole affirmative evidence. As his own account is an interesting one, and has seldom, if ever, been reprinted, our readers may not be displeased to see it here as it stands in Phil. Trans. vol. xli.:—

"An Observation on the Planet Venus (with regard to her having a satellite), made by Mr. James Short, F.R.S., at sunrise, October 23, 1740.—Directing a reflecting telescope of 16·5 inches focus (with an apparatus to follow the diurnal motion) towards Venus, I perceived a small star pretty nigh her; upon which I took another telescope of the same focal distance, which magnified about fifty or sixty times, and which was fitted with a micrometer in order to measure its distance from Venus, and found its distance to be about 10° 2′ 0″ (*sic*). Finding Venus very distinct, and consequently the air very clear, I put on a magnifying power of 240 times, and to my great surprise found this star put on the same phasis with Venus. I tried another magnifying power of 140 times, and even then found the star under the same phasis. Its diameter seemed about a third, or somewhat less, of the diameter of Venus; its light was not so bright or vivid, but exceeding sharp and well defined. A line, passing through the centre of Venus and it, made an angle with the equator of about eighteen or twenty degrees. I saw it for the space of an hour several times that morning; but the light of the sun increasing, I lost it altogether about a quarter of an hour after eight. I have looked for it every clear morning since, but never had the good fortune to see it again. Cassini, in his Astronomy, mentions much such another observation. I likewise observed two darkish spots upon the body of Venus, for the air was exceeding clear and serene."

It has been justly asked by Schorr whether this observer, who was the greatest optician of his time, must not have known his telescopes better than to mistake the reflection of Venus on the eyeglass for a satellite? And Lambert puts the case very strongly, remarking that Short had the object before him for a whole hour with greatly varied powers, and it is not probable that he kept his eye immovable all the time, and after every change in the telescope replaced it at the precise point where the apparent position and distance from Venus would continue unaltered, especially as he used so high a power, with which the slightest change would have been remarked, and a micrometer, the employment of which would have necessarily implied movement in the eye. Lambert might have further strengthened his argument had he had an opportunity of consulting the original record, which shows that another telescope was employed, making in all four eye-pieces, and that Short viewed it not continuously, but at intervals during an hour, increasing every time the chance of detection; nor should the important consideration be overlooked that, with the higher powers, the apparent motion of the planet through the field would be rapid enough to give the illusion a movement in the reverse direction, which would unmask it at once. An examination of one of Short's reflectors might be necessary to decide whether with *his* power of 240 (he was said to have considerably over-rated his magnifiers) the field would have included the attendant with the primary.

The evidence against Father Hell's explanation had even previously become very formidable. The conditions under which his "ghost" is visible are so restrained, the limits so narrow, that there is considerable presumption in any individual case against such an illusion having been formed, or at least against its having passed unchallenged, when a trifling change in the supposed obliquity of indirect vision would at once shift the position of the false image with respect to its origin, and an equally minute alteration in the distance of the eye would deface or obliterate it. But if this is so in each separate instance, the enumeration of so many, with instruments and observers so varied, increases the improbability afresh at every remove, and the careful observation of a man like Short is peculiarly conclusive against the possibility of deception, at least from the assigned cause.

Thus far the advocates of a satellite have it their own way; and to what has been said they would add some curious facts as corroborative evidence. The object, when its size has been remarked, has always been recorded of the same magnitude, one-fourth, or less than one-third, of its primary. It showed itself seven times in one month (March 1764), at a period when telescopes were no longer in their infancy, and in two places at a great distance from each other. And its position-angles, which chance would have placed anywhere, agree sufficiently well with orbital revolution to admit of the calculation of a period, which Lambert has given at 11d. 5h., to which, however, Schorr prefers his own of 12·17d. Many astronomical details are probably accepted among us for which there are no stronger grounds of belief.

But it is one thing to invalidate an opponent's conclu-

sion—another, to establish one's own. As we have already remarked, the abandonment of Hell's solution is not the demonstration of a satellite; and we have yet to hear the opposite side. Some adverse points we have noted as we have passed along; and we might have added the fact that at the epoch of Rodkier's second observation Uranus and Venus were not far apart; perhaps "within blundering distance." But of course the main strength of the denial lies in the fact that, though the alleged appearance can require but little optical advantages, it has been so frequently sought in vain through a long series of years. During that very spring of 1764, when the primary occupied an especially favourable position, it was very carefully looked for by many observers—among others, the acute and experienced Messier, but nowhere seen except at Copenhagen and Auxerre. Cassini and Short, with interest awakened by their own apparent success, could never with all their diligence recover it; and the latter, twenty-three years after his own striking observation, was thought by Lalande, then in London, to disbelieve the satellite's existence. Not to mention Bianchini and others, the elder Herschel never saw a trace of it; nor Schroter, the close observer of Venus during fifteen years; nor Harding, nor Struve, nor Lamont, Smyth, De Vico, Secchi, or any other of the first observers armed with the first telescopes of modern times. And though the subject has now ceased to attract attention, yet, in the unprecedented multiplication of observers and instruments, it would hardly have had a chance of escape. On the whole, therefore, though the evidence may exclude the intrusion of an ordinary "ghost," it seems irresistible against the reality of a satellite.

What, then, was that which was seen? for that something really has been seen, the character of some at least of the witnesses renders a certainty. A reflection in the telescope independent of the position of the eye would have been always visible as a permanent defect; and the fact of its never recurring is equally adverse to the idea of a satellite, and that of an instrumental deception. The only alternative which remains would seem to be that of atmospheric reflection, or "mirage." There would certainly be some difficulty in finding a parallel among recorded facts, though Brewster, if I recollect aright, speaks of having once seen two images of the crescent moon; but the known instances of atmospheric illusion are some of them so very strange and inexplicable, and yet so abundantly attested, that we may possibly, though with little confidence, seek in this direction a solution of the ancient mystery.

Before concluding these remarks, I may be permitted to relate something which fell under my own notice many years ago, and which may perhaps have some connection with the present subject. The observation which I am about to describe took place in the year 1823; it was not reduced to writing till nine years afterwards, but the recollection of it was then very vivid and fully to be trusted; and a small diagram of the relative position of the objects made at the time in the margin of a pocket-book of that year fixes the date to May 22. Until that evening I had never seen the planet Mercury, but finding that he was then in a favourable position I looked out for him with a little common hand-telescope (my near sightedness and the want of an eye-glass preventing me from detecting him otherwise), and soon found him low in the sunset horizon. The telescope in question had a good achromatic object-glass of 1·3 inch aperture and 14 inches focus, and was fitted with a terrestrial eye-piece, magnifying perhaps thirteen or fourteen times; it was a favourite instrument in those early days, and I had succeeded in detecting with it several of the brighter nebulæ and clusters, especially, at the extreme limit of visibility, the large nebula in Triangulum (M. 33). When I had looked at Mercury, I turned to Venus, then high in the S.W., and saw a star, exactly resembling Mercury, or a miniature Venus, *p* or *s p* the planet, at a short distance, perhaps 20′ or 30′, and ¼ or ⅓ of its diameter, or rather its impression on the eye, as of course with so low a power the disc of the planet could not be well made out. I had, when I wrote, a very distinct recollection of its great resemblance to Mercury. My mother, who had an excellent sight, coming into the garden, I showed her Mercury and this appearance with the glass, and she not only saw it readily, but we both believed afterwards that she perceived it without that aid. On the next evening, or more probably on the next but one, I could not find it again. As far as I can ascertain, I had in those early days no knowledge of the suspicion that had been entertained of a satellite: and I did not enter it, as in that case I should have done, in a little note-book of remarkable phenomena that I kept. Through the kindness of Mr. Lynn I have been enabled to ascertain that the star ε Geminorum was not far from the planet on that day, only about 30½′ further S., which would agree very fairly in that direction, but lying 6½ m. more to the E. Independently of this discrepancy—a serious one, for I have no doubt of the *p* or *s p* position of the satellite, not only clearly remembered but shown in the little diagram—it does not seem probable that a star of 3–4 mag. should have been so conspicuous in such an instrument in the twilight. I have no note of the hour, but as Mercury had not sunk into the smoke of the town (Gloucester) in the W. horizon, it must have been comparatively early, and at that time of year the twilight is strong. It may be too hazardous under all the circumstances to include this with the other observations of the pseudo-satellite, but there seems no reason why it should pass into entire oblivion.

T. W. WEBB

THE MISSING LINK BETWEEN THE VERTEBRATES AND INVERTEBRATES[1]

THE views which Dr. Dohrn has recently put forth as to the details of the steps by which the vertebrate stock arose out of an ancestry not very much unlike the existing Annelids, are of such interest that, notwithstanding previous reference to the subject, no apology is needed for presenting the readers of NATURE with a condensation of the main argument contained in "The Origin of Vertebrata."

Dr. Dohrn first draws attention to the correspondences between vertebrate and insect embryos, which have been too little regarded in consequence of our designating the nervous side in the one as dorsal, in the other as ventral. Yet the facts that, in both, the nervous system is developed on the convex side of the embryo and acquires a strong convex flexure anteriorly, and that the body-cavity is finally closed up on the side of the body opposite to the nervous system, point to a common origin at a comparatively high level. The surface of the animal which is called ventral is determined by the presence of the mouth on that surface; and if any Vertebrates had a mouth-opening between the brain and the spinal cord on the dorsal surface, that dorsal surface would necessarily become ventral. Since, moreover, the ancestors of the Vertebrata must have had a nervous ring surrounding their gullet, it would appear more reasonable to suppose that the mouth-opening had been changed in the course of development than that the situation of the nervous centres had been altered. We are thus led to look for traces of an old mouth-opening on that surface of the early Vertebrates which corresponded to our dorsal surface, and to seek reasons for regarding our present mouth as a comparatively modern development.

Dr. Dohrn believes that the old mouth passed through the nervous centres between the crura cerebelli, or more

[1] Der Ursprung der Wirbelthiere und das Princip des Functionswechsels: Genealogische Skizzen von Anton Dohrn. (Leipzig. Engelmann)

accurately, in the fossa rhomboidea, or fourth ventricle, which is remarkable for being of greater proportionate size early in development, and afterwards undergoing retrogression. At an early stage we only need to conceive a slit to be made in the nerve tube at the bottom of the fossa rhomboidea, in order to furnish a suitable passage into the alimentary canal. His first reason for regarding the vertebrate mouth as a modern structure is that it arises so extraordinarily late in development. The embryonic body is almost completely framed, all the great systems are established, the circulation is in active operation, while as yet there is no mouth. Again, the mouth does not arise in the position in which it permanently remains in the great majority. It undergoes considerable shifting forwards. Only in the Selachians and Ganoids does it retain its primitive situation. Moreover, the study of development is steadily tending to establish the idea that the mouth of Vertebrates is homodynamous with the gill-clefts. It is limited, like them, by a pair of arches, lies just in front of the first pair of gill-clefts, arises simultaneously with them in the embryo, and opens into the alimentary canal. A glance at the ventral surface of a Ray shows the likeness of the mouth to a pair of coalesced gill-clefts. Consequently, it becomes probable that the present mouth-opening once existed and functioned as a gill-cleft; that at a certain period in the ascending development, both the old and the new mouths supplied nourishment, that the latter gained the predominance, and that finally the old mouth became aborted.

The next problem attacked is the origin of the gill-clefts. A very elaborate account is given of the supposed process by which the external gills and segmental organs of Annelids were metamorphosed into the gills and gill-clefts of Vertebrates and the skeletal elements connected with them. The great difficulty which Dr. Dohrn confesses in this matter is the connection of the inner extremities of the segmental organs with the wall of the alimentary canal. But if this be granted it is comparatively easy to understand how the shortening and widening of the segmental organs might give rise to gill-cavities such as those of the Selachians. The process by which Dr. Dohrn conceives that the limbs of Vertebrata might have been developed from two pairs of gills in Annelids is a great evidence of ingenuity, though it is to be expected that it will be viewed rather incredulously.

It follows from the view of the origin of Vertebrates thus expounded that Amphioxus loses much of its interest, for there is no place for Amphioxus among Annelids, nor among the primordial Vertebrates; it lacks almost all that they possess. Yet nothing can be gained by excluding Amphioxus from the Vertebrates; for it is so connected with the Cyclostome fishes that it cannot be placed at any great distance from them; while on the other hand it is so related to Ascidians, that the latter must be included among the Vertebrata.

Dr. Dohrn then proceeds with a long argument to show that the Cyclostome fishes are degenerate from a higher type of fishes, and that Amphioxus is a result of still further degeneration. He shows how their mode of life necessitates many of the modifications they have undergone; and that the diversities of the details of structure in Cyclostomes are inconsistent with their being viewed as representing stages in upward development. Finally, the larva of Ascidians is represented as a degenerate fish—a degenerate Cyclostome possibly—which carries to the extreme all the departures of the latter from the fish-type. The most important element in this degeneration results from the fact that Ascidians, instead of being attached to fishes or to any objects from which they can derive nutriment, are fixed to stones, plants, &c., or to such parts of animals (cephalothorax of crabs, tubes of tubicolous annelids) as do not afford them nourishment. Consequently they have lost the old mouth in the organ of attachment, homologous with that of all Vertebrates, and have developed a new one, homologous with the nasal passage of *Myxine*. Thus we can explain the astonishing fact that the mouth-opening of the Ascidian-larva has a communication with the fore-wall of the so-called cerebral vesicle. It is the last vestige of the openings in the nasal sacs by which the olfactory nerves entered.

The most patent objection to Dr. Dohrn's view about Amphioxus is that it fails to account for the development of a many-segmented respiratory apparatus as a degeneration from a higher animal with a small number of gill-arches. It would appear far more reasonable to suppose Amphioxus to be a degeneration from a much lower elevation than the Cyclostome type, viz., from some stage where the respiratory apparatus retained the multiserial character derived from its Annelid forefathers.

The keynote of the author's reasonings is to be found in the principle of Transformation of Function (*Functionswechsel*), on which he lays great stress. He states it as follows:—The transformation of an organ happens through a succession of functions being discharged by one and the same organ. Each function is a resultant of several components, of which one constitutes the chief or primary function, while the others are lower or secondary functions. Diminution of the importance of the chief function with increase of the importance of a secondary function, alters the entire resultant function; the secondary gradually rises to be the chief function, the resultant function becomes different, and the consequence of the whole process is the transformation of the organ. This principle is considered to be a complete answer to the difficulty so strongly insisted on by Mr. Mivart, the incompetency of natural selection to account for the incipient stages of subsequently useful structures. Dr. Dohrn's statement of his principle does not strike us as very different from Mr. Darwin's ("Origin of Species," 5th edition, p. 251), though a little more definitely stated. Mr. Darwin says: "The same organ having performed simultaneously very different functions, and then having been in part or in whole specialised for one function; and two distinct organs having performed at the same time the same function, the one having been perfected whilst aided by the other, must often have largely facilitated transitions." The illustrations given by Dr. Dohrn of the steps by which the anterior extremities of Crustacea became applied to mastication, how the mouth of Vertebrates originated from a pair of gill-clefts, how the respiratory apparatus of Tunicates originated from that of Vertebrates, &c., are, however, exceedingly interesting.

An English translation of Dr. Dohrn's pamphlet could not fail to be serviceable to the large number of students who take an interest in the genealogical problems of morphology. G. T. BETTANY

MAGNETIC OBSERVATIONS IN CHINA[1]

THE first annual report of the magnetic observations at this new observatory has just reached Europe, and it contains results of considerable interest to those engaged in the study of terrestrial magnetism.

The position of Zi-ka-wei is 31° 12′ 30″ N., and 8h. 5m. 45s. E. of Greenwich, being rather less than four miles to the S.W. of Shang-Hai. The observatory is in possession of an excellent set of instruments for determining the absolute values of the magnetic elements, procured by the kind assistance of the Director of Kew Observatory, and a set of self-recording magnetographs by Adie, verified at Kew, have just been erected in a suitable building. The observer, the Rev. M. Dechevrens, S.J., spent a considerable time at Stonyhurst Observatory previous to his departure for China, in order to make himself thoroughly acquainted with the methods of observation, and with the use of the instruments.

The observations in the report extend from April 1874 to March 1875, and furnish the following data for the epoch Oct. 1, 1874:—

1 "Observatoire Météorologique et Magnétique de Zi-ka-wei." Chine, Magnétisme Terrestre, 1874-5.

Declination	1° 54′·72 W.
Dip	46° 15′
Total Force...	10·04850

The value of the declination is very reliable, as it depends on observations taken every half hour from 6 A.M. to 6 P.M. on four days each month in 1874, and on eight days a month in 1875. The dip results from six complete observations, and the horizontal component of the intensity was determined twice a month in 1874, and every week in 1875.

Previous dip observations at Shang-Hai, by Sir E. Home in 1843, and by Capt. Shadwell in 1858, give – 2′·2 and – 3′·4 as the secular variation for 1851 and 1862, the latter differing but slightly from the present variation in England.

Comparing the monthly means of the horizontal force for the winter and summer of 1874–75, we find an excess of 0·00074 in favour of the winter, when the sun is nearest the earth. The extreme variation is only 0·00577, and both maximum and minimum occur in the summer months.

From a limited number of night observations it appears that the range of the declination needle is much more confined, whilst the sun is below the horizon than during the day hours. The diurnal variation is regular throughout the year, but the daily changes in winter are less simple than those of summer. The following are the mean results for the separate seasons:—

	Mean. ° ′ ″	Min at	° ′ ″	Max at	° ′ ″
Spring ..	1 50 49	9 A.M.	1 47 33	2 P.M.	1 54 3
Summer	1 49 39	8 ,,	1 45 45	2 ,,	1 53 3
Autumn	1 59 35	9 ,,	1 58 9	1 ,,	2 1 10
Winter	1 58 51	9 ,,	1 57 32	1 ,,	2 0 5

The time of the principal minimum is more constant than that of the maximum, the latter being anticipated by one hour in winter.

A sudden change from 1° 50′ 13″ on Sept. 21 to 1° 56′ 51″ on Sept. 26, 1874, seems to require further confirmation (which it did not receive in 1875) before it can be considered as more than accidentally connected with the passage of the sun through the autumnal equinox.

The monthly mean value of the declination is greatest in November and least in June, and the absolute maximum and minimum were:—

2° 3′ 49″ at 11h. 15m. A.M. on November 8,

and

1° 41′ 58″ at 9 A.M. on June 29.

giving a yearly range of only 21′ 51″, whilst the secular variation amounts to + 5′·85 The value on Nov. 8 was also evidently increased by some irregular disturbance.

The comparison of the yearly means for the different hours with the hourly means for each season, shows that the sun's position with regard to the equator has a decided effect on the magnetic declination, as increase and diminution in summer invariably correspond with diminution and increase in winter.

In discussing the hourly velocity of the needle, it is found that the acceleration is greatest between 10 and 11 A.M., when the magnet is near its mean position, and that the A.M. maximum velocity is an hour earlier, and the P.M. maximum an hour later in summer than in winter, the greatest velocity being about 1″·5 per minute.

The mean amplitude of the daily excursions of the declination magnet is 7′·88 in summer against 3′·68 in winter, June giving the maximum mean amplitude of 9′·06, and December the minimum of 2′ 95. The value of 1′·92 in February appears to be exceptional. The greatest extent of a daily oscillation in the course of the twelve months was 11′·05 on June 1, and the least 1′·13 on Feb. 20, giving a maximum yearly variation of 9′·92.

The changes of the magnetic elements appear to be remarkably small throughout, and very free from irregular disturbances. The care with which the observations are taken, and the efficient way in which they are discussed, are an earnest of the plentiful harvest we have every reason to expect from this land once so famous, but hitherto so neglected by modern science.

Stonyhurst Observatory, April 13 S. J. PERRY

THE CHALLENGER EXPEDITION

WE have great pleasure in availing ourselves of the permission to publish the following correspondence which has passed through our hands, and in congratulating the staff of the *Challenger*, on having deserved so weighty a testimonial of success. It is an additional assurance that their three years' labour has not been in vain, that so many distinguished men of science have been impelled to speak of it in such terms, as well as a guarantee to the British Government that they did a wise thing in equipping the expedition; we hope it will be an encouragement to the latter to continue to deserve such golden opinions.

To the Editor of "Nature"

Vienna, June 12, 1876

SIR,—After having followed the reports of the naturalists of H.M.S. *Challenger* with the utmost interest, we beg leave to ask you kindly to transmit this simple but sincere expression of a hearty welcome and of thankful admiration to these distinguished gentlemen, as well as to the officers and the crew of this gallant ship, which has been called to render such prominent services to science. Yours most respectfully,

EDW. SUESS, M. P. Prof. University, Vienna,
C. CLAUS,
G. TSCHERMAK,
F. STEINDACHNER, Director of the Imper. Zoolog. Museum,
DR. FR. BRAUER, Custos of the Imper. Zoolog. Museum,
E. V. MARENZELLER,
Prof. Dr. J. HANN,
F. KARRER,
TH. FUCHS, Custos am k.k. Hof. Min. Cab.,
PELZELN, Custos am k.k. Zoolog. Cabinete.

To this the following reply has been made by Sir C. Thomson:—

To the Editor of "Nature"

20, Palmerston Place, Edinburgh, June 23, 1876

MY dear Sir,—I received your note and enclosure last evening. Will you allow me through you to express on my own part and on that of my colleagues Civilian and Naval on board the *Challenger*, our deep gratification at the kind way in which the leaders of Natural Science in Vienna have expressed their approval of our efforts to extend the limits of knowledge in Physical Geography?

We hope that the Empire, which by the most instructive voyage of the *Novara* immediately preceded us in a similar line of research, may be among the first to aid in filling up the rich details of the new zoological region of which we have been able hitherto to supply only an outline.

I am, my dear Sir, yours very faithfully,

C. WYVILLE THOMSON,
Director of the Civilian Scientific Staff of the *Challenger* Expedition.

ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE[1]

III.

Experimental Researches on Anæsthesia Local and General.

THE revival of methods for rendering surgical operations on men and animals perfectly painless, while it has been one of the greatest of the advances of modern medical art, has not been without its alloy. The present generation can scarcely appreciate what were the scenes of the operating theatre before the introduction of anæsthesia. The present generation that is not medical cannot appreciate now what is the scene at an operation when the agent employed to prevent pain proves an agent of death. One surgeon I know has been present at six of these fatal catastrophes under and from anæsthetics. Such an experience shakes the strongest heart. Here is a human being talking cheerfully and resigning himself with full confidence to his medical friends. The operation to be performed may be the act of seconds

[1] Continued from p. 152.

only, but the dread of the pain enforces on the operator the necessity of administering the anæsthetic. A few inhalations of the narcotic vapour are made, and in an instant the body, a moment or two ago animated and full of life and energy, is lifeless in the hands of the administrator of the narcotic.

There is no more painful agony to a practitioner of medicine than a catastrophe of this character. He feels as if the whole beneficent art of anæsthesia were, after all, a mockery; as if it were better that tens of thousands should suffer pain than that one should die under his directing hand merely to save a brief period of pain.

From the first of the reintroduction of anæsthetics these unhappy fatal failures from them have occurred to darken with the shadow of death the retreat of pain from the earth. What more natural, what more humane a labour than that which is devoted to the discovery of a means by which this shadow of death may also be made to fade from the picture? To me this labour has been a life's work. I have pursued it in two directions.

(a) By endeavouring to discover anæsthetic methods which shall carry with them no danger to life

(b) By endeavouring to discover means that shall restore safety when danger is incurred from the use of the present imperfect anæsthetics.

In conducting both these lines of research it has been necessary to experiment on the inferior animals. There is no other method. If the most promising new chemical agent for anæsthesia were put into my hands to-day by the scientific chemist, I could not administer the agent direct to the human subject on mere speculation. It is true I have, from long experience, been able so to understand the characters of anæsthetics that I can formulate them theoretically. If the chemist gives to me a substance and tells me its atomic composition, its physical properties of solubility, of weight, vapour density, and boiling point, I know at once whether it is or is not an anæsthetic, and I can reject on the spot some substances from and by reason of this knowledge, all of which, by the way, has been acquired by experimental research. But if the chemist gives to me the very thing I want it is still impossible to proceed to apply it to practice on man before testing its action on animals inferior to man, for I have found that some of the very simplest and seemingly most innocuous of substances are most fatal.

One of the pioneers of anæsthesia with whom I had the privilege to live and work, did once introduce into practice a new, effective, and, in atomic construction, very simple anæsthetic In the course of a comparatively few administrations of this agent to man, two deaths resulted. To the end of the useful life of this, my friend, he never ceased to regret that he had not first subjected the agent to more vigorous tests of action on animals inferior to man. Once in my researches I got under observation another anæsthetic which seemed perfect. I should have introduced it into practice, had not the lesson I had learned above corrected the error. For on submitting the new agent to the required strain of experiment, I found it so fatal to animals that had I put it forward I should certainly have deepened the shadow of death on the picture of retreat of pain. Twice in the same manner I have prevented other men from introducing anæsthetics which did not bear the full test of proof of experiment on the inferior animal. The reasonable mind will take in all these practical points, and, I think, will come to the conclusion that for no application to the necessities of man and of all other animals could the lives of inferior animals be more justly applied. To kill animals for food, to apply them to works of useful labour, is not more just.

Method of Experimentation.

The method of experimentation I have pursued has taken two courses:—

(a) The subjection of animals to narcotising gases or vapours for the purpose of inducing in them anæsthetic sleep, observing the action of the narcotic through all its degrees of action, and the mode in which it destroys life when it is pushed to the point of destruction of life.

(b) The subjection of animals to local methods of abolishing pain, or, more correctly, of destroying pain in parts of the body locally, so that operations may be performed painlessly while the general consciousness remains, and without any danger at all to life.

In carrying out the first of these inquiries, the plan pursued was as follows:—A narcotising chamber was used, the precise capacity of which was determined. The chamber, made of glass and iron, was, when closed, air-tight, but it was furnished with openings through which it could be charged with the precise measures of the narcotic vapour or gas required. It was also so arranged that the temperature and dryness, and when necessary, pressure of the atmosphere within it could be moderated. Briefly, the chamber was so constructed that the action of every volatile narcotic substance could be tested in it under all known external conditions.

The animals subjected to experiment have as a rule been of two kinds—rabbits and pigeons. Rabbits have been used because when they are allowed to sleep to death in the vapour, or when they accidentally sleep to death, they are good subjects for examination after death, and tell clearly the reason of death. Pigeons have been used for two reasons: first because they succumb more easily to anæsthetics than any other animals, easier even than man; secondly because during sleep they give indications of dangerous or troublesome effects, such as rigidity and vomiting, quite as easily as man. If, therefore, a pigeon will go safely and easily through an anæsthetic sleep, the inference is fair that a man will do so; and in all cases where I have found the anæsthesia so safe and satisfactory on these animals—rabbits and pigeons—as to commend the anæsthetic which produced it, I have always proceeded to try the effect on the human subject by inhaling the anæsthetic myself until it produced the insensible sleep.

In experimenting on the animals, they have been gently introduced into the narcotic chamber from above, and as they have passed into insensibility, each of the stages of narcotism—usually four in number—have been carefully recorded by their phenomena. The facts have been tabulated in set form so as to show, per-centage of vapour diffused, time required to produce insensibility, period of each stage, muscular disturbance, state of the respiration, state of the heart pulse, change of animal temperature, and condition of the pupil. In cases of recovery from the anæsthetic, the signs and period of recovery have been recorded; in cases of death in the anæsthetic sleep, the time and mode of death whether by the heart or by the respiration, have been recorded.

I should remark that these researches have not been made at any regular times. They have been suggested by the study of some chemical substance which presented some promising qualities for the object in view. I believe no new substance of this kind has for the last twenty-five years escaped my observation.

On the animals themselves no pain can be said to have been inflicted. The worst that has happened to them has been that they have passed into deep sleep and have waked again just as a human being who has taken chloroform successfully for an operation, sleeps and wakes. Or else they have passed into sleep and from sleep into death, a mode of dissolution so serene, so painless, as to be an enviable imitation of natural euthanasia.

In the researches on local means of relieving pain, the part to be anæsthetised has been simply subjected to the action of the anæsthetic. At first I used lower animals for this method of inquiry, but owing to their comparative low sensibility they proved unsatisfactory. A mode of local anæsthesia which on a dog or rabbit seems abso-

lutely perfect may, I found, be most imperfect on a man or woman. I once thought I had established a perfect local anæsthesia by applying to animals narcotic solutions locally, in combination with a gentle continuous electric current. It seemed to me that the current caused a rapid absorption of the narcotic, or so acted with it on the minute blood-vessels as to produce contraction of them and destroy local insensibility. Under this plan I performed a number of operations on the lower animals without exciting the slightest evidence of pain. When I came to man the process broke down; some insensibility was, without doubt, produced, and seventeen operations were performed by the local plan. But the more exalted sensibility of the higher animal was not satisfied, and I learned that what would do perfectly for a dog was quite inefficient for a human being.

It is a curious episode in this research and worthy of record, that one of my scientific critics, the late Dr. Waller, a man of great genius, actually showed that he could perform on dogs without any anæsthesia at all, the same operations that I performed with this local anæsthesia, and with similar apparent freedom from pain. The result was that I continued all my after experiments on local anæsthesia, first on my own body, and then on other human subjects who required such anæsthesia for operation. All my experiments with sprays to produce insensibility by intense cold, on Dr. James Arnott's most original design were first performed in this manner, and the process was only applied to the inferior animals after it had been made perfect for the surgical purposes for which they required it. In this instance therefore man became the subject of physiological experiment for the benefit of the inferior animals as well as for his own.

Primary Results of the Experimentation with Anæsthetics.

The primary results of these experiments on different modes and processes for inducing anæsthesia may be put forward in a few sentences. They were all of them results which could not have been reached by any other line of research.

1. The experimentation has enabled me, as a physician, to keep on a level with the chemist in applying to the services of man all those agents for the relief of pain which the chemist produces. The chemical bodies of the methyl, ethyl, butyl, and amyl series with several others which have promised to be of any service have been tested, and their respective values carefully chronicled.

2. For general anæsthesia I have been enabled, by the research to add many new and useful anæsthetics. Bichloride of methylene, which has been very largely used, and which Mr. Spencer Wells invariably uses with signal success for ovariotomy, came from this research. Methylic ether, the safest anæsthetic I have yet known, was proved by this research. Methylal, another very valuable agent of the same kind, and which has to be practically applied, is another good anæsthetic added by these inquiries; while several agents tried for anæsthesia which have not answered, have been accidentally discovered to possess other and valuable curative properties. The introduction of the etherial solution of peroxide of hydrogen, an exceedingly useful remedy, and the local use of butylic alcohol for toothache, are two instances amongst many more of this kind.

3. The researches have enabled me to formulate the physiological properties of the organic bodies that produce anæsthesia, so that the value of the anæsthetic compounds may be calculated from their physical characters and composition. I have been able to show that some elements—such as chlorine—are objectionable parts of an anæsthetic agent, others favourable; that certain degrees of solubility are objectionable, others favourable; that certain vapour-densities are objectionable, others favourable. I have been able to point out a distinct theoretical standard of qualities which, being found, will yield a safe, manageable, and agreeable anæsthesia. Lastly, I may add, from an experience in the study of anæsthetics extended from the time when they were first introduced until this hour, the positive assurance that careful and steadily pursued experimental research must result in the discovery of all the laws relating to anæsthesia, and to the further discovery of an absolutely safe mode of producing it. For I have learned that no man, no animal, ever yet has died because it was rendered insensible to pain, and the deaths which have occurred have invariably been due to some property of the substance used that had no relation to the anæsthetic property—some independent bad quality which we may fairly expect science to eliminate for the benefit of man.

4. While striving to apply the results of experimentation to the advantage of the human family, I have not forgotten the inferior creation, and in nothing have I been more successful than in their behalf. For operations on animals I have been able to make the application of local anæsthesia so perfect that there is no necessity whatever that any lower animal should ever feel a pang from the knife of the operator for any external cutting operation it may have to undergo. The Society for the Prevention of Cruelty to Animals has itself published the facts of an operation, for removal of a large tumour from a horse belonging to Sir Wm. Erle, that was performed by my method of operating under ether spray while the animal stood in the stable without halter or bridle, oblivious of all pain. That fact,—one of a hundred similar,—I put forward, not as in itself peculiar, but because of the record from which it is taken. It could not have been recorded even there but for the experimentation that gave it birth.

BENJAMIN W. RICHARDSON

NOTES

HER MAJESTY has been pleased to confer on Prof. Wyville Thomson the honour of knighthood.

IT is stated that Sir C. Wyville Thomson and the members of the scientific staff of the *Challenger* will be entertained at dinner in Edinburgh on July 7. The Lord Provost has consented to take the chair.

WE notice from the official announcement in connection with the Loan Collection, that during the present week, fourteen demonstrations of apparatus were given on Monday, eleven on Tuesday, four on Wednesday and Thursday, while seven will be given on Saturday. With regard to the complaint in the *Times* as to the occasional non-attendance of the lecturers, it should be remembered that these demonstrations are given out of pure good-will by some of the most eminent and busy of the scientific men of the day, who are not always masters of their own time. The Department's arrangements are entirely dependent on the convenience of these men, and it should not therefore be blamed if its proposed programmes are not always rigidly carried out. The following arrangements have been made for future free evening Lectures on the Instruments in the Collection:—Saturday, July 1, Prof. Tyndall, F.R.S., on "Faraday's Apparatus," in the Lecture Theatre, South Kensington Museum; Monday, July 3, the Right Hon. Lyon Playfair, C.B., M.P., F.R.S., on "Air and Airs," as illustrated by the Magdeburg Hemispheres and Black's and Cavendish's Balances; Saturday, July 8, Dr. Gladstone, F.R.S., "The Work of Davy and Faraday," as illustrated by the Apparatus lent by the Royal Institution; Monday, July 10, Rev. R. Main, M.A., F.R.S., on "The Instrumental Foundations of Practical Astronomy;" Saturday, July 15, Dr. W. H. Stone on "Modes of Eliciting and Reinforcing Sound;" Monday, July 17, Mr. C. V. Walker, F.R.S., on "Galvanic Time Signals;" Saturday, July 22, Mr. W. Chandler Roberts, F.R.S.,

SCIENTIFIC SERIALS

THE current number of the *Ibis* commences with two papers on the ornithology of the Fiji Islands, by Mr. E. L. Layard, in which the following species are described:—*Platycercus taviunensis, Myiolestes macrorhynchus, M. compressirostris, Pachycephala torquata.* Additional notes on other birds are given, including *Lamprolia victoriæ.*—Mr. H. Durnford has ornithological notes from the neighbourhood of Buenos Ayres, in which the habits of the birds of the district are briefly described.—Mr. R. Ridgway writes on the genus *Helminthophaga*, precisely defining the distribution of the ten species and their specific characters.—Mr. H. E. Dresser continues his notes on Severtzoff's "Fauna of Turkestan," the species of birds most lengthily noticed being *Leptopoecile sophiæ, Anthus pratensis,* and *Lanius isabellinus,* together with *Caprimulgus pallens* and *C. arenicolor.*—Mr. F. Barratt gives ornithological notes made during trips between Bloemfontein and the Lydenburg gold-fields, figuring *Bradypterus barrati.*—Messrs. H. Seebohm and J. A. Harvie Brown continue their notes on the birds of the Lower Petchora, figuring the eggs of *Squatarola helvetica.*—Mr. J. H. Gurney continues his notes on Mr. Sharpe's "Catalogue of the Accipitres in the British Museum," devoting himself on this occasion to the American Buzzards.—Mr. P. L. Sclater gives an interesting account of the recent ornithological researches of Beccari, D'Albertis, and von Rosenberg in New Guinea, and Count Salvadori writes on two New Guinea species, *Sericulus xanthogaster* and *Xanthomelus aureus.*—Canon Tristram describes a collection of birds from New Hebrides, among which is a new species of *Porphyrio, P. aneiteumensis.*

Poggendorff's Annalen der Physik und Chemie.—Ergänzung, Band vii., Stuck 4.—We have here a valuable second memoir by M. Chwolson on the mechanism of magnetic induction, which process he seeks to explain by the supposed existence of molecular magnets that are turned by the external force in one direction. In his former paper he dealt with the case of temporary induction in soft iron; he here treats of magnetic induction in steel. The paper is in five chapters: in the first are summarised the results obtained by previous observers, those of Jamin being given with special fulness. In the second the author describes his experiments, which require a modification of Jamin's theory. Of Jamin's two laws relating to the action of positive and negative currents on permanently magnetised bars, M. Chwolson finds the first absolutely correct; the second incorrect. Jamin's mistake he considers to be in the supposition that the negative current only acts on the surface layers, leaving those below untouched; it is shown, on the contrary, that the least negative current acts on all the layers and diminishes their intensity. Then he gives a mathematical theory of induction in steel; supposed the first attempt of the kind (if Maxwell's but partly successful one be excepted). In the fourth chapter he explains, on the basis of theory, the various experimental results got by different observers; and in the fifth, shows how certain results that might *à priori* be foreseen, from the theory, have been verified.—M. Holtz has a paper on some changes of form of the Leyden battery (with a view to extending the length of spark), and its use with influence-machines; and he describes some good phenomena of discharge. The remaining papers are extracts.

Der Naturforscher, February.—In this number we may note an account of observations by M. Mallard on the velocity of inflammation in a mixture of fire-damp and air. The various mixtures were set in motion with different velocities, and that velocity at which the zone of combustion remained stationary measured the velocity sought. The highest velocity of inflammation was 0·560 metres in a second, and it occurred in a mixture of 0·108 vol. of fire-damp in one volume of the mixture. On increasing or diminishing the proportion of fire-damp, the velocity in question diminished very rapidly, becoming *nil* with a proportion of 0·077 vol. on the one hand, and 0·145 vol. on the other, below which the mixtures are neither explosive nor inflammable. It is notable that a variation of even 0·01 in the proportion of fire-damp is sufficient to convert an absolutely indifferent mixture into a highly dangerous one.—In geology there is an adverse criticism of Mr. Mallet's theory of volcanic action, by M. Roth, and an experimental inquiry by M. Hoppe-Seyler into the formation of dolomite. The latter points out that wherever, on a sea-bottom covered with chalk or limestone, eruptions of lava occur, dolomite is a necessary product, the lava supplying the temperature (which must be high), the limestone the calcium and carbonic acid, and the sea-water the magnesium.—From twenty years' observations in St. Petersburg, M. Rikatcheff draws some conclusions as to the influence of cloudiness on the daily variations of temperature.—We further note an abstract of a recent *brochure* by Prof. Lommel, on the interference of reflected light (the author developes variously a well-known experiment of Newton), and a summary of an interesting lecture by M. Löwe to the Physiological Society of Berlin, on the theory of descent.

March.—The formation of cheese has lately engaged the attention of Prof. Ferd. Cohn in connection with his researches on the lowest forms of plant life; and he has made personal observations on the manufacture, as carried on in Switzerland. The phenomena accompanying the process are thus described: The rennet contains a liquid ferment which causes coagulation of the milk; also ferment-organisms (Bacillus), which probably bring on butyric-acid fermentation, and cause the slow maturing of the cheese. It is their resting-spores that, enclosed by the dry cheese substance, resist boiling heat for a long time, and, in a suitable nutritive liquid, may afterwards develop to bacillus rods. (One of Dr. Bastian's results is thus explained.)—In a paper by M. Rosenthal, the action of the automatic nerve-centres is explained as dependent, not on some immanent property of the nerve apparatus, but on the nature of the blood. To account for the rhythmus of the movements in breathing, he supposes a constant resistance opposed to the constant excitation, and illustrates the case by supposing a vertical tube closed below by a plate which is pressed against it by a spring, while a constant stream of water flows in from above. When the liquid reaches a certain height the spring yields, and some water escapes; then the spring forces back the plate, and the process is repeated, thus giving a rhythm. From experiments made by M. Bartoli, in Italy, it is inferred that all solid and liquid substances, whatever their nature, have, in air, a damping influence on the oscillations of a magnetic needle suspended over them, and that this action depends on the air that is between the two surfaces. Among other subjects handled in this number may be mentioned those of irregularities of the sea-level (Hann), the molecules of isomeric and allotropic bodies (Smit), the physical properties of litter in woods (Ebermayer), and decomposition of albuminous matter in animal bodies (Drechsel).

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 4.—Supplementary note "On the Theory of Ventilation" (see NATURE, vol. xi. p. 296). By Francis S. B. François de Chaumont, M.D., Surgeon-Major, Army Medical Department, and Conjoint Professor of Hygiene, Army Medical School. Communicated by Prof. Stokes, Sec. R.S.

In his previous paper the author endeavoured to establish a basis for calculating the amount of fresh air necessary to keep an air-space sufficiently pure for health, taking the carbonic acid as the measure. The results showed that the mean amount of carbonic acid as respiratory impurity in air undistinguishable by the sense of smell from fresh external air was under 0·2000 per 1000 volumes. His object in the present note is to call attention to the relative effects of temperature and humidity upon the condition of air, as calculated from the same observations.

Linnean Society, June 1.—Prof. Allman, president, in the chair.—An interesting series of photographs illustrating coffee cultivation in Ceylon, an enormous banyan tree and other tropical vegetation, were shown by Mr. J. R. Jackson, of the Kew Museum; Mr. W. Bull's exhibition of several fine healthy, growing plants, and the seeds of his lately introduced *Coffea liberica* and of *C. arabica* for comparison came in most *à propos* to the above.—The Rev. G. Henslow read a paper on floral æstivations, in which, after giving the eight kinds, viz., distichous, tristichous, pentastichous, half-imbricate, imbricate proper, convolute, valvate, and open, he explained their origin, and specially dwelt upon the new term *half-imbricate*, which he applied to a very large number of cases ranging from perfect regularity to extremely irregular and zyomorphic flowers of the pea and snap-dragon. The author then showed how that, as well as the fifth and sixth kinds were successively deducible from the third or pentastichous (quincuncial) by merely shifting one edge of the *second* part *under* the adjacent edge of the *fourth* part. The author added a note on a new theory of the cruci-

ferous flower, based on a quinary type, and which, by *symmetrical reduction* (*i.e.*, the fifth part of each whorl would be suppressed) the remaining fours would, by further arrest, due to adaptations to insect agency, form the normal flower. He also disputed the tenability of *Chorisis* in the pairs of long stamens, regarding their occasional union as indicative of evolutionary advance and not retrogression; as cohesion is a subsequent stage to freedom, except in the rare cases of atavism indicated by solution and dialysis. The author called in question the justness of Pfeffer's view of the corolla of primula, being an outgrowth of the Andrœcium, by showing (*a*) the position of the stamens to be explained by the staminodia of Samolus, (*b*) that the corolla appearing subsequent to the stamens is no anomaly, (*c*) that the fibro-vascular bundles are ten in number, of which five are intermediate, and (*d*) that phyllotactical æstivation were those of true leaves; so that all these facts conspired to render the theory untenable. Mr. J. G. Baker read a paper on a collection of ferns made by Mr. Wm. Pool in the interior of Madagascar. Altogether 114 species have been obtained, of which fifteen are entirely new and twenty-eight prove to be varieties of already known forms. Some examples, *e.g.*, *Asplenium trichomanes*, *Nephrodium felix-mas*, and *Aspidium aculeatum*, are thoroughly temperate types.—Mr. Francis Darwin read an account of some researches of his on glandular bodies on *Acacia sphærocephala* and *Cecropia peltata*, serving as food for ants. The structures in question were discovered by Mr Belt (Nicaragua), and subsequently further observations made by Fritz Muller (Brazil), while Mr. Darwin has more particularly entered into their minute composition. In Acacia they are of two kinds (*a*) nectar-secreting glands situate at the base of the petiole, (*b*) small, somewhat flattened, pear-shaped bodies, which tip six or seven of the lowermost leaflets of the bipinnate leaves. In Cecropia cylindrical bodies are developed in flat cushions at the base of the leaf-stalk. Mr. Darwin shows the microscopical structure of all of these to be homologous in kind, cellular, protoplasm, and containing oil globules. He infers, moreover, they bear a relation to the serration-glands of Reinke, in certain cases afterwards being converted into stores of nutriment, which undoubtedly the ants live on, and in their turn protect the trees from the ravages of the leaf-cutting ants.—A notice of the lichens of Madagascar collected by Mr. W. Pool, by the Rev. J. M. Cerombie, was taken as read.—Prof. Wyville Thomson, of the *Challenger* Expedition, addressed the meeting, giving the results of two communications by him; one on new living Crinoids belong to the Apiocrinedæ, the other on some peculiarities in the mode of propagation of certain Echinoderms of the Southern Seas.

Royal Astronomical Society, June 9.—William Huggins, D.C.L., president, in the chair. A paper by Prof. Simon Newcomb was read on a hitherto unnoticed apparent inequality in the longitude of the moon. The inequality was, it appeared, brought to light in the course of an investigation which has recently been made by Prof. Newcomb, of the corrections to be applied to Hansen's "Tables de la lune," in order that they may be used for the determination of the longitudes of the transit of Venus stations. Prof. Newcomb set himself to compare the places derived from Hansen's Tables with the series of lunar observations made at Greenwich and Washington between the years 1862 and 1874. The residual errors of the moon's place showed a systematic inequality which could not be got rid of by any new assumption as to the value of the corrections of the lunar elements. There can be no serious doubt about the existence of the inequality, because both the Greenwich and Washington observations agree in showing it, and a close investigation shows that the errors are periodic and depend upon the moon's longitude. In order to make the investigation more complete, Prof. Newcomb has determined the corrections for the years 1847 to 1858, for which period the residual errors of Hansen's Tables are given in the Greenwich observations of 1859. A table of the resulting corrections is given in the paper, and it appears that the period of the chief term of the new inequality is 16½ years with a probable error of half a year. The corresponding period of the inequality in longitude is 27·4304 days ∓ 0·0040 days, and there is a large preponderance of probability against the real period being less than 27·42 days, or more than 27·44 days. No known term in the moon's longitude falls within these limits. The moon's sidereal period is 27·32 days and the anomalistic period is 27·55 days, so that the new term falls half way between the two. The non-accordance of this period with any term heretofore sought for, is the probable reason why this term has not before been noticed; a term if unknown would not be remarked unless its value was such as visibly to effect the individual comparison of theory with observation, and Hansen's tables as corrected are the first of which the residual errors are so small that a term of 1″·5 would be remarked in the comparison with observations. Prof. Adams said that he was at a loss to imagine what the cause of this inequality can be, he was rather inclined to suppose that it may have something to do with the effect of the figure of the earth on the motion of the moon, but this was only an idea thrown out on the spur of the moment.—Lord Lindsay exhibited an adaptation of the ordinary altazimuth instrument designed to give a rough equatorial motion; to the base of the altazimuth pillar is fixed an iron bar, through a hole in which a [illegible] or wire is attached to the object-glass end of the telescope; that the only adjustments that are necessary are that the horizontal hole shall be placed approximately north and south, and the distance from the base of the altazimuth pillar to the hole in the bar through which the string passes shall be equal to the height of the pillar into the cotangent of the latitude of the place of observation.—Mr. Plumber read a paper on photometric experiments upon the light of Venus. By comparing the shadow of a wire cast by the light of the planet with the shadow of a similar wire cast by a candle at a known distance, and again by comparing the light of the candle with the light of the full moon, he came to the conclusion that the light of Venus at its greatest brilliancy was equal to $\frac{1}{799 \cdot 5}$ of the brightness of the full moon, and by a similar method found that the light of Jupiter at mean opposition was equal to $\frac{1}{6430}$ of the light of the mean full moon.

Chemical Society, June 15, Dr. J. H. Gladstone, F.R.S., vice-president, in the chair.—A large number of communications were read, this being the last meeting of the season. The first paper, by Prof. Dewar, entitled "Chemical Studies," was chiefly devoted to an account of several interesting lecture experiments.—Dr. H. E. Armstrong then gave a short account of his elaborate researches on the reduction of nitric acid and on the oxides of nitrogen, part i., on the gases evolved by the action of metals on nitric acid, made in conjunction with Mr. Acworth.—Mr. C. T. Kingsett then read a paper on the composition and formula of an alkaloid from Jaborandi.—There were also papers on the simultaneous action of iodine and aluminium on ether and compound ethers, by Dr. J. H. Gladstone and Mr. A. Tribe; on compounds of antimony pentachloride with alcohols and with ethers, by Mr. W. C. Williams; on the volatility of barium, strontium, and calcium, by Prof. J. W. Mallet; on the action of chlorine on acetamide, by Dr. E. W. Prevost; note on the perbromates, by Mr. M. M. P. Muir, and a communication on a new and convenient form of areometer for clinical use, by Dr. J. G. Blackley.

Geological Society, June 7.—Prof. P. M. Duncan, F.R.S., president, in the chair.—John Thos. Atkinson, Edmund Clark, Frederick Derry, Walter S. Gervis, Thos. Jones, Baldwin Latham, and Edward Sewell, were elected Fellows of the Society.—On the British fossil cretaceous birds, by Prof. H. G. Seeley, F.L.S. In this paper the author gave an account of the remains of birds which have been collected from the Cambridge Upper Greensand. The bones are so fragmentary that the size of the animal can only be given roughly as similar to that of the Diver, but with a shorter neck. The affinities of the animal are strongest with *Colymbus*. It also closely resembles Prof. Marsh's cretaceous genus *Hesperornis*, and like that genus may be supposed to have had teeth. The species were described as *Enaliornis Barretti* and *E. Sedgwicki*. Some bones were also described thought to indicate birds in which the extremities of the bones remained unossified throughout life.—On two chimæroid jaws from the Lower Greensand of New Zealand, by E. T. Newton, F.G.S., of H.M. Geological Survey. The two jaws which were the subject of this communication form part of the collection of fossils from the Lower Greensand of New Zealand deposited in the British Museum by Dr. Hector. One of the specimens, a right mandible, was referred by the author to *Ischyodus brevirostris*, Ag., a species from the Gault of Folkestone, hitherto known only by name, no description or figure of it having been as yet published. The second specimen, a small right maxilla, possessing but one tooth, and this of a peculiar form, was compared with the corresponding form in *Ischyodus*, *Edaphodon*, *Elasmodus*, *Ganodus*, *Chimæra*, and *Callorhynchus*. Reasons were given for

believing that it differed generically from all other known forms of Chimæroid jaws; and the author therefore proposed to call it, in allusion to the form of the tooth, *Upsilodus Hutori*.—On a bone-bed in the Lower Coal-measures, with an enumeration of the fish-remains of which it is principally composed, by J. W. Davis, F.L.S. In this paper the author described a thin bed composed chiefly of remains of fishes. which rests immediately upon the "Better-bed coal" of the Lower Coal-measures in Yorkshire.—Note on a species of Foraminifera from the Carboniferous formation of Sumatra, by M. Jules Huguenin. Communicated by Prof. Ramsay, F.R.S., V.P.G.S. The author described some globular Foraminifera, belonging or allied to *Fusulina*, from a carboniferous deposit containing *Producti* and *Phillipsiæ*, which occurs north-[illegible] Padang and south of the lake of Singkarak in Sumatra. [illegible], and [illegible]thor described the structure of these fossils, which he [illegible] *C. aren*[illegible] with *Fusulina cylindrica* and *F. depressa*, and arrived [illegible] [illegible]clusion that they belong to a new genus, to which [illegible] North American *Fusulina robusta* also belongs.—On t[illegible] Triassic rocks of Somerset and Devon, by W. A. E. Usher, F.G.S. The author stated that the Trias of Devon and Somerset was divisible into three groups, occupying distinct areas. The first lies north of the Mendip Hills, where the Trias is thinnest and assumes its simplest characters, consisting of marls and Dolomitic conglomerate. The second area embraces the country south of the Polden Hills as far as a north and south line through Taunton. The chief portion of the Trias in this area, as in the northern, consists of marls. The third area, bounded on the north by the Bristol Channel, on the south by the English Channel, on the east by the Blackdown range, and on the west by [illegible] Culm and Devonian highlands, presents the most complex r[illegible]ons of the Trias in the south-western counties.

Victoria (Philosophical) Institute, June 19.—A paper by Prof. Morris, M.D., of Michigan University, on the theory of unconscious intelligence as opposed to theism, was read. The paper discussed the theories which have been put forward on the subject. The professor laid down the proposition that consciousness and intelligence imply one another, and that, therefore, "unconscious intelligence" is a self-contradictory phrase.

PARIS

Academy of Sciences, June 12.—Vice-Admiral Paris in the chair.—The following papers were read:—Experimental critique on Glycemia (continued). Physico-chemical and physiological conditions to be observed in searching for sugar in the blood, by M. Cl. Bernard. The sugar found normally in blood of animals ranks among glycoses. M. Bernard shows how its properties may be demonstrated after coagulation of the blood, by superheated steam, by alcohol, or by sulphate of soda. He then details his mode of finding the amount of sugar.—On the absorption of free and pure nitrogen and hydrogen by organic matters, by M. Berthelot. White filter paper, slightly moist, placed in pure nitrogen, under influence of the effluve or silent discharge, absorbs a considerable quantity in eight or ten hours. Oxygen does not hinder this (in 100 vols. air, 2·9 hundredths of nitrogen and 7·0 of oxygen were absorbed in about eight hours). Hydrogen is absorbed even more rapidly than nitrogen by benzene, terebenthene, acetylene, &c.—On the formation and the decomposition of binary compounds by the electric effluve, by M. Berthelot. In principle the reactions are the same as those with the spark, but the longer duration of the spark and the heating it produces are adverse to the formation of condensed products, such as arise under the effluve.—Presentation of solar photographs of large dimensions, by M. Janssen. In these the disc is 22 centimetres in diameter, yet there is great distinctness. M. Cornu hopes shortly to have photographs from the focus of a telescope of 36 centimetres aperture.—On electric transmissions through the ground, by M. du Moncel. From experiments he shows how unequal moisture about the electrodes, unequal heating of these, and unequal size, are physical causes which intervene, more or less, causing variations in intensity of currents transmitted through the ground. A general conclusion is, that it is not advantageous to interpose earth in a circuit unless when its resistance exceeds 10 or 15 kilometres of telegraph wire.—On some new experiments made with Crookes's radiometer, by M. Ledieu. In the first experiment rotation was obtained from a beam of luminous rays falling parallel to the axis (though less rapid than when it falls at right angles). In the second, the two sides of the vanes were kept bright; and here the vanes moved as if repelled by the luminous ray meeting them. (The ray should be made to strike the vane next the light at a small angle, and the two opposite vanes, with reference to the plane of the ray and the axis, be shaded by a screen. The place should be quite dark.)—On amber, by M. Reboux.—On the law of Dulong and Petit, by M. Terreil. The product of specific heat by chemical equivalent is a constant, provided all the bodies are taken with the same gaseous volume, and before any condensation. The specific heat of simple bodies, taken with the same volume and gaseous state, is inversely proportional to their chemical equivalents; so is that of compound bodies, and it is proportional to the condensation of the gaseous volumes of the constituent simple bodies in combining. Simple or compound bodies which have lost the gaseous state have a specific heat double that which they have in this state.—Letter to M. Dumas on Phylloxera, by M. Fatio. The cycle of metamorphoses may, in certain circumstances, occur entirely under ground without intervention of the perfect winged form.—On the employment of sulphide of carbon against Phylloxera, by M. Allies.—Another on the same subject, by M. Marion.—On the pantanemone, an apparatus acting in all winds, without orientation and without reduction of surfaces, by M. Sanderson.—Ephemerides of the planet (103) Hera, for the opposition of 1877, by M. Leveau.—On the presence of magnesium in the sun's limb, by M. Tacchini. The magnesium gains in intensity and elevation where the flames of the chromosphere present most vivacity. While there is at present a minimum of spots, protuberances, hydrogenic clouds, and metallic eruptions, the circulation of magnesium still retains a certain energy capable of rising to a maximum as in previous years.—Phenomena of electric oscillation, by M. Mouton.—On the propylenic chlorhydrines and the law of addition of hypochlorous acid, by M. Henry.—Elementary analysis of electrolytic aniline black, by M. Goppelsrœder.—On anthraflavone and an accessory product of the manufacture of artificial alizarine, by M. Rosenstiehl.—On the internal membrane of a chicken's gizzard as an osmotic partition, by M. Carlet. Interposed between water and alcohol in the normal conditions of osmose, this membrane is always traversed by a dominating current from the water to the alcohol; it is therefore not (as generally supposed) an exception among animal membranes.

VIENNA

Imperial Academy of Sciences, Feb. 17.—The following (among other) papers were read:—Further observations on the formation of a rational space curve of the fourth order, on a conical section, by M. Weyr.—On the distribution of the colouring matter in ovules during the process of division, by M. Schenk. The ovaries and testicles of *Echinus saxatilis* are commonly yellowish, but some species have reddish violet ovaries; M. Schenk studies the changes wrought by artificial fecundation of the ovules in these latter with sperma from the yellow testicles.

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THURSDAY, JULY 6, 1876

A PHYSICAL SCIENCE INSTITUTE

PROBABLY the present generation knows little of the conditions under which the great exhibition of 1851 was organised, or of the important results which followed it. After clearing all the expenses of that enterprise, a large surplus remained, to administer which a Royal Charter was granted to the Commissioners who managed the Exhibition. Since 1852 the Commissioners have held numerous meetings, and quietly done a large amount of work from which the nation has reaped great benefit. Much of the success of the various departments connected with the South Kensington Museum is due to the help they have been able to give, and now they propose a scheme whereby a large proportion of the property at their disposal will be allotted for the benefit of science and art. The Commissioners recently held a meeting, under the presidency of the Prince of Wales, at which their Special Committee reported on various schemes for making use of their funds and property.

The Commissioners started with a clear capital of 186,000*l*. They have given to the Government, for the use of the South Kensington Museum, property valued at 14,000*l*., and 60,000*l*. in land. They have sold to the Government, at half the value, land for the Natural History Museum, worth 240,000*l*. They have given the site of the Royal Albert Hall, worth 60,000*l*., and retain property in it to the extent of 80 000*l*. They have invested 100,000*l*. in the galleries lent to the India Museum and Science Loan Exhibition. Notwithstanding these very considerable contributions, the Commissioners still possess out of the Kensington Gore estate, which they purchased with the surplus funds of the 1851 enterprise, landed property of very great value. We believe that the whole of the site of the International Exhibition buildings, including the Horticultural Gardens, and some adjacent properties are in the trust of the Commissioners. Five schemes have been thought of for the utilisation of this valuable property. By one of these the Commissioners could realise one million sterling, and yet retain a square of ten or twelve acres in the centre of their property. But this they do not think of adopting. The one which they seem to regard most favourably is to lease or sell the ground outside the arcades, called the East and West Annexes, and retain the Horticultural Gardens and Exhibition Buildings, by which means they would realise upwards of 350,000*l*., free from all liabilities. Whichever scheme is adopted—and the Commissioners seem to think the time is ripe for making the best of their trust in "the interests of science and art"—a very large sum will be at their disposal.

Various objects, all in accordance with the purpose for which they were originally appointed, seem to have suggested themselves to the Commissioners for the appropriation of these funds. Scholarships in science and art, it is suggested, might be founded in connection with central institutions and provincial colleges of science and art, such as those at Manchester, Birmingham, Bristol, Leeds, and elsewhere. It would be a great benefit, it is thought, to these new institutions if their more promising students could be brought up to the laboratories of chemistry, physics, and biology, which are in active work at South Kensington. A portion of the funds might also, it is thought, be devoted to the promotion of museums of science and art throughout the country, and in making grants in aid of the British Section at International Exhibitions; also in supplying several crying wants in connection with the South Kensington Museum, and erecting other buildings on the estate to be devoted to science and art.

The Commissioners are naturally anxious for the welfare of their own child, the South Kensington Museum, and for the proper exhibition of the treasures it contains, and the proper housing of its educational and other libraries. This has engaged much of their attention, more especially as the executors of the late Mr. Dyce insist on the carrying out of the provisions of his will with regard to the display of his bequest. Since the subject, however, has been under the consideration of the Commissioners, Government has made a grant of 80,000*l*. for the purposes of Art, part of which will, no doubt, be devoted to the proper allocation of the Dyce and other collections, and to some of the other purposes concerning which the Commissioners are naturally anxious. Had they been aware of this grant, no doubt they would have spoken more fully and decidedly of another scheme which appears to have come under their consideration.

The scheme to which we refer was briefly described by Mr. Cross recently in the House of Commons, and has reference to the establishment of "a museum and scientific institute, which would comprise a library of works in science and art, for the use of students at South Kensington, and public examination rooms." From the way in which the library is here mentioned we may consider that it is a matter of secondary importance in the eyes of the Commissioners, and that the main idea is to build a museum and laboratory. We confess we cannot see the immediate appropriateness of attaching a library to a laboratory and museum of this kind. At present no library of science exists, and there will be a library attached to the Natural History Museum which is now being erected on the Commissioners' grounds, and there are various places in London where the best works and serials in all departments of science can be easily consulted. There is at least no pressing need at present for a science library, while the necessity for the organisation of a laboratory and museum was never more urgent. It is known that if only a suitable receptacle were provided, many of those who have contributed to the Loan Collection are willing to leave their apparatus permanently as the nucleus of an English Conservatoire des Arts et Métiers. No better opportunity could be afforded for the commencement of a science museum; but if the Commissioners do not resolve without delay to carry out the scheme that has apparently been engaging their attention, a golden opportunity will be lost that is not likely to occur again soon.

As to the proposal to provide rooms in the Science Museum for examinations in connection with the Science and Art Department, we think the Commissioners would be doing a quite unnecessary and rather mischievous thing in carrying out such a proposal. Government has started these examinations, and is no doubt quite prepared to provide examination-rooms for itself. I

needs no leading in this matter, though it certainly does need encouragement to take under its wing a science museum and laboratory. This then it seems to us ought to be the first care of the Commissioners, leaving the examination rooms out of the reckoning, while the library can easily afford to wait for future consideration. If the idea of a library is brought too prominently to the front, we fear the building will come to be known by this and no other name, and come in the end to be mainly, if not only, what its name purports. We believe the Commissioners could spare 100,000*l*. for a Science Museum; and we are sure the great success which has attended the Loan Collection will tend to confirm them in their intentions, and induce them without delay to set about providing a permanent successor. We have no doubt that the Commissioners are quite alive to the value of a Physical Science Museum and Laboratory, and feel strongly the great need there is in this country for such an institution. They have on the whole done their work conscientiously and well, and South Kensington testifies to the highly important and beneficial results which they have accomplished. By erecting an institution for the promotion of physical science, they will show their anxiety to make their work complete in all the departments with which they have had to deal. Twenty years ago they started the Museum of Art at Kensington; if twenty years hence a Museum of Science has made equal progress, the nation will have reason to congratulate itself on the result, and be grateful to the Commissioners for the faithfulness with which they have done their work.

WHEWELL'S WRITINGS AND CORRESPONDENCE

William Whewell, D.D., Master of Trinity College, Cambridge. An Account of his Writings, with Selections from his Literary and Scientific Correspondence. By I. Todhunter, M.A., F.R.S., Honorary Fellow of St. John's College. (London: Macmillan and Co., 1876.)

WE frequently hear the complaint that as the boundaries of science are widened its cultivators become less of philosophers and more of specialists, each confining himself with increasing exclusiveness to the area with which he is familiar. This is probably an inevitable result of the development of science, which has made it impossible for any one man to acquire a thorough knowledge of the whole, while each of its sub-divisions is now large enough to afford occupation for the useful work of a lifetime. The ablest cultivators of science are agreed that the student, in order to make the most of his powers, should ascertain in what field of science these powers are most available, and that he should then confine his investigations to this field, making use of other parts of science only in so far as they bear upon his special subject.

Accordingly we find that Dr. Whewell, in his article in the "Encyclopædia Metropolitana," on "Archimedes and Greek Mathematics," says of Eratosthenes, who, like himself, was philologer, geometer, astronomer, poet, and antiquary: "It is seldom that one person attempts to master so many subjects without incurring the charge and perhaps the danger of being superficial."

It is probably on account of the number and diversity of the kinds of intellectual work in which Dr. Whewell attained eminence that his name is most widely known. Of his actual performances the "History" and the "Philosophy of the Inductive Sciences" are the most characteristic, and this because his practical acquaintance with a certain part of his great subject enabled him the better to deal with those parts which he had studied only in books, and to describe their relations in a more intelligent manner than those authors who have devoted themselves entirely to the general aspect of human knowledge without being actual workers in any particular department of it.

But the chief characteristic of Dr. Whewell's intellectual life seems to have been the energy and perseverance with which he pursued the development of each of the great ideas which had in the course of his life presented itself to him. Of these ideas some might be greater than others, but all were large.

The special pursuit, therefore, to which he devoted himself was the elaboration and the expression of the ideas appropriate to different branches of knowledge. The discovery of a new fact, the invention of a theory, the solution of a problem, the filling up of a gap in an existing science, were interesting to him not so much for their own sake as additions to the general stock of knowledge, as for their illustrative value as characteristic instances of the processes by which all human knowledge is developed.

To watch the first germ of an appropriate idea as it was developed either in his own mind or in the writings of the founders of the sciences, to frame appropriate and scientific words in which the idea might be expressed and then to construct a treatise in which the idea should be largely developed, and the appropriate words copiously exemplified—such seems to have been the natural channe of his intellectual activity in whatever direction it over flowed. When any of his great works had reached this stage he prepared himself for some other labour, and if new editions of his work were called for, the alterations whicl he introduced often rather tended to destroy than to com plete the unity of the original plan.

Mr. Todhunter has given us an exhaustive account o Dr. Whewell's writings and scientific work, and in this w may easily trace the leading ideas which he successivel inculcated as a writer. We can only share Mr. Tod hunter's regret that it is only as a writer that he appear in this book, and it is to be hoped that the promise account of his complete life as a man may enable us t form a fuller conception of the individuality and unity of hi character, which it is hard to gather from the multifariou collection of his books.

Dr. Whewell first appears before us as the author of long series of text-books on Mechanics. His position a a tutor of his College, and the interest which he took i University education, may have induced him to spen more time in the composition of elementary treatises tha would otherwise have been congenial to him, but in tl prefaces to the different editions, as well as in the intr ductory chapters of each treatise, he shows that sense the intellectual and educational value of the study of fir principles which distinguishes all his writings. It manifest from his other writings, that the composition these text-books, involving as it did a thorough study the fundamental science of Dynamics, was a most app

priate training for his subsequent labours in the survey of the sciences in their widest extent.

"It has always appeared to me," says Mr. Todhunter, "that Mr. Whewell would have been of great benefit to students if he had undertaken a critical revision of the technical language of Mechanics. This language was formed to a great extent by the early writers at an epoch when the subject was imperfectly understood, and many terms were used without well-defined meanings. Gradually the language has been improved, but it is still open to objection."

In after years, when his authority in scientific terminology was widely recognised, we find Faraday, Lyell, and others applying to him for appropriate expressions for the subject-matter of their discoveries, and receiving in reply systems of scientific terms which have not only held their place in technical treatises, but are gradually becoming familiar to the ordinary reader.

"Is it not true," Dr. Whewell asks in his Address to the Geological Society, "in our science as in all others, that a technical phraseology is real wealth, because it puts in our hands a vast treasure of foregone generalisations?"

Perhaps, however, he felt it less difficult to induce scientific men to adopt a new term for a new idea than to persuade the students and teachers of a University to alter the phraseology of a time-honoured study.

But even in the elementary treatment of Dynamics, if we compare the text-books of different dates, we cannot fail to recognise a marked progress. Those by Dr. Whewell were far in advance of any former text-books as regards logical coherence and scientific accuracy, and if many of those which have been published since have fallen behind in these respects, most of them have introduced some slight improvement in terminology which has not been allowed to be lost.

Dr. Whewell's opinion with respect to the evidence of the fundamental doctrines of mechanics is repeatedly inculcated in his writings. He considered that experiment was necessary in order to suggest these truths to the mind, but that the doctrine when once fairly set before the mind is apprehended by it as strictly true, the accuracy of the doctrine being in no way dependent on the accuracy of observation of the result of the experiment.

He therefore regarded experiments on the laws of motion as illustrative experiments, meant to make us familiar with the general aspect of certain phenomena, and not as experiments of research from which the results are to be deduced by careful measurement and calculation.

Thus experiments on the fall of bodies may be regarded as experiments of research into the laws of gravity. We find by careful measurements of times and distances that the intensity of the force of gravity is the same whatever be the motion of the body on which it acts. We also ascertain the direction and magnitude of this force on different bodies and in different places. All this can only be done by careful measurement, and the results are affected by all the errors of observation to which we are liable.

The same experiments may be also taken as illustrations of the laws of motion. The performance of the experiments tends to make us familiar with these laws, and to impress them on our minds. But the laws of motion cannot be proved to be accurate by a comparison of the observations which we make, for it is only by taking the laws for granted that we have any basis for our calculations. We may ascertain, no doubt, by experiment, that the acceleration of a body acted on by gravity is the same whatever be the motion of that body, but this does not prove that a constant force produces a constant acceleration, but only that gravity is a force, the intensity of which does not depend on the velocity of the body on which it acts.

The truth of Dr. Whewell's principle is curiously illustrated by a case in which he persistently contradicted it. In a paper communicated to the Philosophical Society of Cambridge, and reprinted at the end of his "Philosophy of the Inductive Sciences," Dr. Whewell conceived that he had proved, *à priori*, that all matter must be heavy. He was well acquainted with the history of the establishment of the law of gravitation, and knew that it was only by careful experiments and observations that Newton ascertained that the effect of gravitation on two equal masses is the same whatever be the chemical nature of the bodies, but in spite of this he maintained that it is contrary not only to observation but to reason, that any body should be repelled instead of attracted by another, whereas it is a matter of daily experience, that any two bodies when they are brought near enough, repel each other.

The fact seems to be that, finding the word weight employed in ordinary language to denote the quantity of matter in a body, though in scientific language it denotes the tendency of that body to move downwards, and at the same time supposing that the word mass in its scientific sense was not yet sufficiently established to be used without danger in ordinary language, Dr. Whewell endeavoured to make the word weight carry the meaning of the word mass. Thus he tells us that "the weight of the whole compound must be equal to the weights of the separate elements."

On this Mr. Todhunter very properly observes:—

"Of course there is no practical uncertainty as to this principle; but Dr. Whewell seems to allow his readers to imagine that it is of the same nature as the axiom that 'two straight lines cannot inclose a space.' There is, however, a wide difference between them, depending on a fact which Dr. Whewell has himself recognised in another place (see vol. i., p. 224). The truth is, that *strictly* speaking the weight of the whole compound is not equal to the weight of the separate elements; for the weight depends upon the position of the compound particles, and in general by altering the position of the particles, the resultant effect which we call weight is altered, though it may be to an inappreciable extent."

It is evident that what Dr. Whewell should have said was: "The mass of the whole compound must be equal to the sum of the masses of the separate elements." This statement all would admit to be strictly true, and yet not a single experiment has ever been made in order to verify it. All chemical measurements are made by comparing the weights of bodies, and not by comparing the forces required to produce given changes of motion in the bodies; and as we have just been reminded by Mr. Todhunter, the method of comparing quantities of matter by weighing them is not strictly correct.

Thus, then, we are led by experiments which are not only liable to error, but which are to a certain extent erroneous in principle, to a statement which is universally

acknowledged to be strictly true. Our conviction of its truth must therefore rest on some deeper foundation than the experiments which suggested it to our minds. The belief in and the search for such foundations is, I think, the most characteristic feature of all Dr. Whewell's work.

J. CLERK MAXWELL

GOULD'S BIRDS OF NEW GUINEA

The Birds of New Guinea and the Adjacent Papuan Islands, including any new Species that may be Discovered in Australia. By John Gould, F.R.S., &c. Parts I., II., and III. (London: Published by the Author, 1875 76.)

NOT long ago we had the pleasure of recording in these columns the completion of one of Mr. Gould's great series of illustrated works on ornithology. We have now to notice the commencement of another work belonging to the same category, of not less importance, on the origin of which we propose to say a few words. The "Birds of Australia" must be known to most of our scientific readers as one of the most important ornithological works ever produced in this or any other country. Defects it has, no doubt—nothing is perfect in this world—but, whereas before its existence the birds of that great continent were almost unknown to naturalists, the termination of Mr. Gould's labours left us with such a history of the feathered inhabitants of this portion of the globe as hardly any other country at that time possessed. Some years after the completion of his "Birds of Australia," Mr. Gould issued the first number of a supplement to the same work, undertaken for the purpose of illustrating the new species discovered by his various agents and correspondents, as new portions of Australian territory were explored. This was completed in 1869, and gave us an account of 81 species, in addition to 600 already included in the original "Birds of Australia." The work of which the two first numbers are now before us - though a different title is given to it—is, in fact, a second supplement to the "Birds of Australia." New Guinea, as is now well understood by naturalists, in spite of a certain amount of idiosyncrasy, belongs essentially to the same fauna as Australia. Long ago it was known that many peculiarities are common to the animal and vegetable products of these two countries. Since Northern Australia has been explored, and further investigation made of the rich fauna of New Guinea, the many points of contact between the natural productions of these two lands have been greatly augmented, and there can be little question that we have in New Guinea an exaggerated reproduction of many of the chief peculiarities of the Australian type. Looking to the great interest that is now more than ever attaching itself to the products of New Guinea, Mr. Gould has very naturally determined to combine his illustrations of the many wonderful birds of that country with the new additions that he still continues to receive from Australia, and this is, in fact, the object of the present work.

The great feature in the ornithology of New Guinea is, as is well known, the Paradise-Birds, which are mostly confined to that country and the adjoining islands, though some of the members extend far into North Eastern Australia. The splendid metallic colouring of these birds and the ornamental tufts and plumes that adorn the adult males, afford welcome subjects to the artist's pencil, and are naturally objects on which Mr. Gould is desirous of showing his habitual skill. We have not, therefore, to turn over many leaves of his first number, before we come across representations of two of the finest members of this group, namely the Six-plumed Paradise Bird, known to naturalists since the days of Linnæus, and D'Albertis' Paradise Bird, one of the most recent additions to this remarkable group. In the second number Mr. Gould gives us figures of the three species of *Diphyllodes*, another remarkable member of the same family. Some of the splendid parrots of New Guinea are likewise depicted.

In the third part of his work, which has only been issued within these last few days, further illustrations of the magnificent group of Paradise-Birds are given. The singular species of *Diphyllodes*, so remarkable for its bare head, which the late Prince Charles Bonaparte, in his democratic ardour, dedicated to the Republic, is among the most striking forms yet discovered even in this wonderful group, and both sexes are admirably figured in the present number. Although originally described from a single imperfect specimen, this striking bird has recently been discovered by Dr. Bernstein living in the islands of Waigiou and Botanta, and no less than ten specimens obtained by this zealous but unfortunate explorer ornament the gallery of the Leyden Museum. The King Bird of Paradise (*Cicinnurus regius*) is another species selected by Mr. Gould for illustration in the present number. Although known to us since the last century, it is only of late years that perfect specimens have reached the collections of Europe. Our countryman, Mr. Wallace, was one of the first naturalists to observe it in its native forests, and his eloquent account of the specimens obtained by him in Aru will be known to many of our readers. Still more recently, the naturalists in the employ of the Leyden Museum and the Italian explorers D'Albertis and Beccari have sent to Europe a large number of specimens of it. Five charming parrots of the most brilliant and strongly contrasted colours, several of which are hitherto unfigured, are likewise depicted in Mr. Gould's third number.

The part terminates with figures of two recent additions to the Avifauna of Australia. Of these the two named *Sternula placens* is perhaps rather a doubtful species as regards its novelty to science, though doubtless new to the Australian list. The second *Glyciphila subfasciata* is one of Mr. E. P. Ramsay's interesting discoveries in Northern Queensland, and is one of the smallest and most plainly coloured of the great and characteristic of the Australian family of Honey-eaters.

In concluding our notice of this important work, we may venture to say that those who are acquainted with the author's failing health, cannot but admire the spirit which he has displayed in commencing it, while every one will, we are sure, heartily join with us in wishing him complete recovery and a successful accomplishment of his arduous task. When one of our Italian friends has recently described fifty-two new species of Papuan birds in a single memoir, even Mr. Gould's well-known energy will have to exert itself considerably in order to keep up with what is going on.

OUR BOOK SHELF

Famines in India; their Causes and possible Prevention. Being the Cambridge Le Bas Prize Essay, 1875. By A. Lukyn Williams, B.A. (London: Henry S. King and Co., 1876.)

WE have in this prize essay a very creditable digest of a mass of blue books touching on a subject of the greatest importance to India, and to ourselves. Mr. Williams has first sought to interest his readers by recalling famines nearer home and their dreadful consequences; he has then divided his subject into two parts, the first occupied with the causes, the second with the possible prevention of famines in India.

The chief causes producing a failure of crops are to be found in the land having too little or too much water,—in the failure of the seasonal rains, or in floods from overcharged rivers; to which must be added the wants due to the difficulty of conveying food from places where it is abundant to those where its production has been destroyed. There can be little doubt as to the common causes of famines in India; the important question is how they are to be prevented.

Is it possible to be prepared for a failure of the seasonal rains, that is, can we foresee by our present knowledge, that a year, half a year, or even three months hence there will certainly be a great deficiency of rain over a given district or country? This, we have to confess, is at present beyond our power. Meteorology cannot yet be called a science; it is a series of fragmentary facts; a mass of undigested observations; a groping after laws through false hypotheses which have gained their position through celebrated names. As long as men like Galileo were satisfied with the hypothesis that nature abhorred a vacuum, all progress in hydrostatics was impossible. Although we have got over that, the spirit which kept Aristotle alive is still above ground, and meteorology will scarcely advance unless facts are studied independently of the views of any master as to their causes. What hereafter may be possible in the way of prediction is too wide a subject for this notice.

Failing the foreknowledge required to be prepared for the want of rain, there remains the very practical process of being provided with water, through canals and aqueducts connected with the many perennial sources of India. Mr. Williams appears to have referred little to the views of Sir Arthur Cotton on this part of the subject, though these are of the highest value. When both rain and aqueducts are wanting, good means of communication with more favoured districts are essential (these are indeed essential in any case), great central railways are required for our hold, and proper government of the empire, but these are too costly to satisfy for many long years the real requirements of such a people and of such a country. Wherever they can be made, canals, which serve as great lines of communication and feeders of aqueducts for irrigation, are apparently best suited to the present wants of India: these, with large reservoirs, which could frequently be constructed at moderate expense, would diminish to a great extent the possibility of famine.

That forests retard the discharge into rivers of the fallen rain, and diminish the height of floods, is a fact now so well known that the planting of trees and the preservations of woods, especially on steep slopes, has been recognised as essential to the protection of every land subject to inundations. Mr. Williams has treated of these and many other matters, including the improvement of agriculture and land tenure, in a way which shows he has mastered the reports of several highly distinguished officers who have studied these questions on the spot; and the essay will give readers interested in its subject a very satisfactory idea of the facts connected with it.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Lectures on Meteorology

MOST people conversant with the subject will agree with "Spes" (vol. xiii., p. 169) that meteorology should now be considered as much a separate science as mineralogy or geology, and be taught as such; but I would suggest whether without waiting for the foundation of special chairs in the colleges, immediate steps might not be taken with advantage to bring it before the class of persons not usually to be found in colleges, to whom it is of essential importance, by means of the Science and Art Department Organisation.

Physical Geography, which may be considered as a somewhat kindred science, is, I believe, one of the most popular amongst the candidates for the South Kensington certificates, and by the directory for 1875 it appears that in that year this subject was taught in 686 classes to 17,720 students, thus heading the list of science schools, for the next two subjects in popularity; Elementary Mathematics and Electricity, only number 537 and 485 classes, with 10,502 and 12,515 students respectively.

Dr. Hooker, P.R.S., the learned director of the Royal Gardens, Kew, in arranging the science lessons given during the winter to the young gardeners training in that establishment has, for the past two years, caused a course of lectures on Meteorology to be delivered in addition to the lectures on Botany, Chemistry, &c., and examinations have been held and certificates awarded for proficiency in this science equally with the others.

The movement to spread the knowledge of the principles of meteorology must be a strictly educational one, for experience proves that it is useless to attempt to popularise it by means of lectures to institutions, &c.; for although offered gratis to committees and managers, these are as a rule very reluctant to accept them, as from the absence of brilliant experiments or optical illustrations, they fail to attract large audiences.

The steps taken by the British Meteorological Society during their last and previous sessions, which have resulted in the addition to its ranks of so many officers of health and civil engineers, show that interest is not wanting in the science; and it is only to be regretted that "Spes" has brought forward his proposal so late in the season, that no opportunity can occur for bringing it before the society before their next winter session.

The want of text books on the science now felt would soon disappear, as publishers would at once bring out works on the subject, were a demand for them to arise.

Richmond G. M. WHIPPLE

The Axolotl

WHEN, in 1873, Mr. Mivart published in your pages, in his papers on "The Common Frog," an account of the Mexican Axolotl, I arrived theoretically at conclusions which are, I think, identical with those reached by Weissmann, whose researches, recorded in the *Zeitschrift fur Zoologie*, you published in abstract on the 8th inst. Mr. Mivart says: "Its mature condition was considered to be established by the discovery that it possesses perfect powers of reproducing its kind;" thus seeming to admit that its metamorphosis from the Siredon to the Amblystoma form proves it to have been really a fertile, persistent, larval form. He then used this metamorphosis of a larval into a mature form as a fact in favour of his hypothesis of sudden development; as if the Axolotl and Amblystoma were actually of distinct genera, and not merely the subjects of a mistake arising from partial knowledge, analogous to those by which the larval Nauplius and Zoea were constituted into genera. Sir John Lubbock's remarks on Chironomus ("Origin and Metamorphosis of Insects," p. 76) are relevant. He says: "It seems to me possible, if not probable, that some larvæ which do not now breed, may, in the course of ages, acquire the power of doing so." Persistent larval forms would seem to have originated from adaptational causes, which, Sir John Lubbock remarks, may act through natural selection; and the power of reproduction to have been in time acquired. Any subsequent cases of perfect development from a previously persistent larval form, such as the metamorphosis in question, would seem, as indicated by the absence of sexual power in the resultant Ambly-

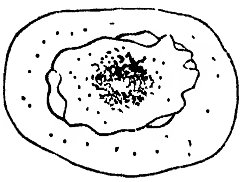
stoma forms, to be analogous to cases of degeneration, or return to an abandoned course of development, rather than to the commencement of a new stage of progress. The adaptational advantages, which caused the larval form to become persistent, ceasing to operate, the Amblystoma form may very possibly, in time, reobtain its reproductive powers and its position as the normally perfect animal of which the Siredon is the larva.

June 28 G. S. BOULGER

Remarks upon a Hailstorm which passed over Belgaum on April 21, 1876

ABOUT 1.30 P.M., after some light rain, large hail-stones commenced falling one here and there, and gradually thickening for ten minutes, were followed up by a sharp shower of rain.

The first stones which fell were of a compressed oval shape, with sides slightly rounded or bulging, about 1 inch in length and ¾ inch in breadth, the centre being about ½ inch thick. The centre or nucleus of the stone was about the size of a large pea, and appeared to consist of a mass of infinitesimally minute air-bubbles. Surrounding this nucleus were two collateral tracings—not rings, for they were far from being round—unlike in form, the one occasionally bulging beyond the other :—



Towards the end of the storm the hail-stones decreased in size and assumed a rounded shape, about ¼ inch in diameter, with the same internal conformation, but proportionately small compared with the size of the stones. G. A. NEWMAN

Williams' (?) Thermometer

As the Physical Loan Collection at South Kensington includes a new (?) thermometer by Mr. John Williams—I presume the son of the late Secretary of the Astronomical Society—I hereby beg to vindicate my priority therein, as printed in the London *Philosophical Magazine* for January 1850, vol. xxxvi. My communication is dated Dec. 6, 1849, wherein I proposed making the common − 40° F. or C. to be the zero, and the boiling-point of water 1000; being 252° F. or 140° C. interval. Also putting zero at − 38° F. to have 250° F. for the extreme difference. This would generally avoid negat. deg. (and even the decimal pointing), merc. freez. − 39 = + 4 or − 4 according to the scale 252 or 250 :—

F. 0 − 158·7	152	F. 150 = 754·0	752
32* = 285·7	280	174 = 849·2	848
39 313·5	308	212* = 1000·0	1000
357·1	352	655 = 2758·0	2772
84 = 492·1	488	672 = 2825·4	2840
98 = 547·6	544		

In a tract on the Limits of the Atmosphere, printed in 1840, I showed that the absolute *zero* of cold is unattainable. Pour any fluid substance in a cylinder, and mark the dilatation points for 32° and 212° F., it is obvious that by carrying the scale downwards to the bottom of the cylinder, that the fluid cannot condense to the very bottom of the vessel, else its density would be infinite. At or before this *lowest* degree of the scale the said fluid will therefore remain stationary or begin to expand upwards, as water does at 32°. I enclose copies printed at the time of my said papers. S. M. DRACH

June 26

The Cuckoo

THERE is a saying in Somersetshire :—

"The Cuckoo sings in April,
The Cuckoo sings in May;
The Cuckoo sings the day before
But not on Midsummer-day."

This year, the cuckoo sang cheerily on the 24th, and is still singing on the 28th with undiminished vigour. H. M. ADAIR

Taunton

Geology of Zermatt

BEING about to spend some time in the Zermatt district, I should be much obliged if any of your readers could give me through your pages (as the information would doubtless be serviceable to others) the titles of such works on the geology and mineralogy of that portion of the Alps as they can recommend from their own use of them. VIATOR

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF 1878, JULY 29.—On March 26 of the present year an *annular* eclipse passed over British Columbia, the sun being high in the heavens and near the meridian when the annulus was formed. On July 29, 1878, the still more interesting phenomenon, a *total* solar eclipse, will be visible in the same district, the track of the central line passing thence over the western states of America to the Gulf of Mexico. Our American *confrères* will no doubt give a good account of it.

The duration of totality attains a maximum in British Columbia, and the present remarks will be confined to the passage of the total eclipse over this country. Employing the *Nautical Almanac* elements, which as regards the moon's place are in very close agreement with those of the American ephemeris founded on the tables of Prof. Peirce, and making a direct calculation for longitude 123° 30′ W., latitude 53° 30′ N., we find the following particulars :—

	h. m. s.		
Totality begins July 29, at	1 32 24 local M.T. at	61 from N.Pt.	towards W.
,, ends ,, ,,	1 35 36 ,, ,,	118 ,,	,, E.

The duration is therefore 3m. 12s. The sun's altitude at the middle of the eclipse is 52°.

A similar calculation gives for the commencement of the partial eclipse 0h. 19m. 47s. local M.T. at 62° from the sun's north point towards the west, altitude 56°.

For any other point not far from the above-assumed position the times of beginning and ending of totality may be deduced from the following formulæ :—

$$\cos w = 51{\cdot}5275 - [1{\cdot}84632] \sin. l + [1{\cdot}67405] \cos. l, \cos (L + 203° 44'{\cdot}5)$$
$$t - 9\text{h}\ 59\text{m}\ 4{\cdot}6\text{s}. \mp [1{\cdot}98370] \sin w \quad [3{\cdot}56410] \sin l$$
$$- [3{\cdot}86142] \cos l, \cos (L + 245° 6'{\cdot}7).$$

The beginning of the partial eclipse will be given by

$$\text{Cos. } w = 0{\cdot}98476 - [0{\cdot}19431] \sin l + [0{\cdot}00582] \cos l, \cos. (L + 184° 34'$$
$$t - 10\text{h}.\ 19\text{m}\ 43\text{s} - [3{\cdot}65657] \sin. w - [3{\cdot}55998] \sin. l$$
$$- [3{\cdot}88264] \cos l, \cos (L + 227° 19'{\cdot}4).$$

In the above formulæ L expresses the west longitude from Greenwich taken *negatively*, l the geocentric latitude, and the quantities within the square brackets are logarithms. Upper sign for beginning of totality, lower sign for ending.

The following figures should define pretty accurately the limits of the belt of totality in British Columbia :—

W. longitude	Geographical Latitude of N. Limit.	Central Line.	S. Limit.
° ′	° ′	° ′	° ′
126 30	56 22·1	55 11·0	54 1·4
123 30	54 42·6	53 30·7	52 20·5
122 0	53 50·5	52 38·4	51 27·9
120 30	52 56·9	51 44·6	50 33·9
117 30	51 5·3	49 52·5	48 41·4

Fort Fraser, it will be seen, is very nearly on the line of central eclipse.

At a point, longitude 121° 37′ W., latitude 52° 27′, just south of Lake Quesnelle, the central lines of the annular eclipse of March, 1876, and the total eclipse of July, 1878, intersect.

At New Westminster, the capital of British Columbia, the eclipse is partial only, commencing at 0h. 30m. and ending at 2h. 59m. local mean times, magnitude 0·95.

BESSEL'S "ABHANDLUNGEN."—The second volume of the reprint of Bessel's astronomical and other memoirs, under the editorship of Dr. Engelmann, of Leipsic, has appeared. The contents relate to the theory of instruments, including the treatises of the great Königsberg

astronomer on the heliometer, which in his hands acquired so universal a reputation; to sidereal astronomy, with the memoirs relating to the parallax of 61 Cygni, the measures of the principal members of the Pleiades, to which Dr. Engelmann has added a chart of the group containing stars visible in a telescope of 10·11 cm. aperture, or to "about 10·11 magnitude," the stars not found in Argelander's *Durchmusterung* having a distinguishing mark. Several mathematical essays follow.

MIRA CETI.—Reference is often made in treatises on astronomy to the unusual degree of brilliancy attained by this variable star at the maximum of 1779. From th observations of Bode, Herschel, and Wargentin, we have the following particulars of the augmentation and diminution of brightness in that year.

Aug. 22.—Invisible in an ordinary 2-feet telescope.

Sept. 8.—Seen with the same instrument but very faint.

Sept. 18.—Immediately visible to the naked eye according to Herschel. Bode estimated it 4m.

Oct. 5 and 6.—Already much brighter than Menkar (α Ceti).

Oct. 15-19.—Equal to α Arietis on 15th, and still brighter on the 19th; the light reddish.

Oct. 30.—According to Wargentin, it was equal to Aldebaran and of the same colour, or even of the redness of Mars which was observable the same night. In a 10-feet achromatic Mira shot out vivid red rays. Herschel considered it midway in brightness between α Arietis and Aldebaran.

Nov. 2. There was even an increase, in the judgment of Herschel.

Nov. 11.—Visible as early as Aldebaran and Mars.

Nov. 20.—As bright as, but not brighter than stars of the second magnitude, according to Herschel, but on the 25th much brighter than Menkar, though less than Aldebaran, according to Wargentin.

Dec. 4.—Only equal to α Arietis.

Dec. 7 and 10.—So much diminished since Nov. 25, that it was now hardly equal to Menkar, and its colour was now whiter.

Dec. 25.—Before the moon rose, equal to γ Ceti, or of the third magnitude.

Dec. 29.—Only a little brighter than the fourth magnitude; not equal to γ or δ Ceti.

Argelander gives for the date of maximum 1779, Nov. 6.

THE TASMANIANS

THE *historical* period of this singular race of mankind has lasted no longer than a century, for up to one hundred years ago they had unimpeded sway in the island of Van Diemen. Once invaded by Europeans, they had inevitably to succumb, and they gradually but speedily dwindled away, the last of them having died about two years ago, so that now they are completely extinct.

The island when discovered by Tasman contained about 7,000 inhabitants. In the year 1803 it was annexed by Britain for a penal settlement. Hatred, amounting to display of violence, broke out between the aborigines and the criminal occupiers of the soil. The scattered remnants of the native tribes were subsequently gathered together, and provided for by the Government at various retreats, until the last of the race in course of time passed away. Dr. Barnard Davis, F.R.S., the well-known ethnologist, in a recent paper,[1] endeavours to prove by the comparison of a skeleton, and some skulls of an Australian and a Tasmanian, that these two people belonged to two distinct races of man, having been previously erroneously confounded together.

[1] "On the Osteology and Peculiarities of the Tasmanians, a Race of Man Recently become Extinct." Reprint 4to from the "Natuurkundige Verhandelingen der Hollandsche Maatschappij der Wetenschappen." 3rd Verz. Deel II, No. 4. Illustrated by four splendid lithographic plates.

Almost the only relics which the Tasmanains have left behind them are their bones. Fortunately before the entire extinction of the race, men of science had begun to see the importance of the study of craniology, so that a few skulls, but still only a few, have been collected and preserved. One chief reason of the scarcity of crania is the manner of the disposal of the dead—by fire. These were often placed in a hollow tree, surrounded by spears, so that on the occurrence of any bush fire the bones even were certain to be consumed. Two out of the twelve skulls in Dr. Davis' collection have been rescued from fire. Up to the last three years there was not a single Tasmanian skeleton in any European collection. At the present time there are four in England - two, one a male and the other a female, being in the Museum of the Royal College of Surgeons. Two skeletons, also of opposite sexes, are in the Museum of the Royal Society of Tasmania, Hobart Town.

The chief works of art, of which, unfortunately, but few are preserved, consist of beautiful necklaces made by stringing the iridescent shells of *Purpura elenchus* upon thin sinews, also of very rude implements, chippings of a dark-coloured chert, exactly like that used by the Kanakas of the Sandwich Islands, and, lastly, fishing nets. The natives on the south and west coasts make a kind of "catamaran" from rushes. The spears, about ten feet long, are made of the heavy, hard wood of the "tea tree" pointed and hardened in the fire, and straightened by being passed from end to end between the teeth.

For long the Tasmanians and Australians were confounded together, and Europeans who visited the country did not improve matters by calling both races, without distinction, "black," though the colour of their skin was removed from a negroid blackness, being of a "dull dark" colour in the Tasmanian, and "chocolate, coffee-coloured, or nutmeg-coloured" in the Australian.[1] There was, moreover, a striking difference between the two people, the Tasmanian being stout and broad-shouldered, while there was such a degree of lankness in the Australian as to cause the former to appear stout. Prof. Huxley, who visited both countries, says of the former people that they "are totally different from the Australians."

The Tasmanians were rather short, being below the average of Europeans in stature. The mean height of twenty three men was found to be 5 ft. $3\frac{1}{4}$ in., or 1,618 mm.; that of twenty-nine women was only 4 ft. $11\frac{1}{4}$ in., or 1,503 mm. There are, however, instances, as in other races, of tall stature among the Tasmanians, for several have been found to be 6 ft. in height by measurement. The Australians are a taller people. Out of thirteen Shark's Bay natives who were measured twelve were 5 ft. 10 in in height, but "there seems," observes Mr. Oldfield, "as much variation among these savages as there is among civilised nations, the mean height being no greater than it is in England." The Tasmanians differed strikingly from the Australians in being robuster; and that this is no superficial character, but one of race, can be proved by reference to their bones. A question, now unfortunately too late to solve, is—What was the amount of difference between the different tribes of Tasmania? For it is known that there were tribes in the island differing to the extent of the possession of dialects mutually unintelligible. With regard to the Australians, some ethnologists maintain that they have physical characters so distinct as to admit of being divided into a woolly-haired and a flowing-haired race.

There is, moreover, a striking difference in the structure of the hair in the two races respectively; that of the Australians growing in flowing ringlets, while the hair of the Tasmanian, being excentrically elliptical on section, has a tendency to twist, and thus comes to grow in small

[1] It is to be hoped that in future, in order to avoid such vagueness of terminology, travellers will adopt M. Broca's useful colour-types. *Vide* the British Association's "Anthropological Notes and Queries."

corkscrew locks. This peculiarity allowed them to load their hair with red ochre, so that it hung down in separate ringlets. In colour it is of a very dark brown, popularly called black, approaching in tint to No. 41 [1] of Prof. Broca's "Colour Types." It was difficult to investigate the hair of the women, as, from an idea that it added to their charms, they shaved their heads either with a sharp stone or with broken bottles, on the advent of civilisation! The women among the Mincopies of the Andaman Islands have the same custom. It is a curious coincidence also that the latter race, as did the Tasmanians, were in the habit of carrying fragments of the bones of their relations, as a mark of affection, suspended necklace-wise round their necks. The peculiar growth of hair in spiral tufts is *natural* to these races, which have peculiar crisp excentrically elliptical hair, and is no work of art, being of spontaneous growth, contrary to the assertions of those whose ideas of race are founded on missionary models. The hair on all the other parts of the body, of which there was no deficiency, was of the same character, there being even on the borders of the whiskers little pellets of hair on the cheeks, "like pepper-corns." The nose of the Tasmanian was not elevated, but very broad across the alæ. The upper lip was long, and the mouth wide, but of a pleasant, calm expression. In the strength of the jaws, moreover, the size of the teeth, and the large area of the grinding surface of the molars, the Tasmanians agree with the Australians, and contrast strikingly with European races.

There is a peculiarity in the physiognomy of the Tasmanians which is difficult to describe to others, but which is obvious to those, who, like Dr. Davis, have long studied their crania. It consists in "a particular roundness, or spherical form, which manifests itself in all the features." Dr. Paul Topinard, too, states ("Etude sur les Tasmaniens," Mém. de la Soc. d'Anthrop. de Paris, iii. 309) that there are certain marks in the cranium which would "enable him to recognise it anywhere."

The thickness and density of the bones of the skull, even in women, is very striking, and "constitutes a decided peculiarity of the race." The frontal and parietal bones, for instance, of a small woman's skull, from which the calvarium had been sawn off, was 0·4 inch, or 6 millimetres, in thickness. The orbits in the Tasmanian skull are, according to Dr. Topinard, small. He says, moreover, that the skull has a sinister expression, while, on the other hand, Dr. Davis regards the countenance of the Tasmanian as a "benevolent, if not mild," one.

With regard to prognathism, both in superior alveolar and in inferior alveolar, or *mental* prognathism, the Australian cranium much exceeds that of the Tasmanian.[2] This is well seen in Dr. Davis's plates (Tab. II. III.).

Touching cranial capacities, Dr. Topinard concludes that "the anterior lobes of the brain have *nearly the same* relative development in the two series of skulls, *i.e.*, the Tasmanians and others" [that is, Parisian and Breton skulls taken for comparison]. "The anterior part of the posterior cerebral lobes is a *little less* developed in the Tasmanians. The posterior part is *much less* developed. The cerebellum is more voluminous in the Tasmanians, by a quantity approximately equal to the loss which the posterior cerebral lobes undergo."

On examining the skeleton of a Tasmanian it will be observed that the bones have the usual robustness seen in European skeletons, differing thus quite from those of the Australian, which are slender. In two skeletons each belonging to one of these races, the last rib was in both three inches long, while in those of an Australian woman described by Prof. Owen this rib was but little more than one inch in length. The ilia are decidedly more everted in the Tasmanian than in the Australian. The patellæ are also larger in the former. There is no olecranon foramen in the humerus of either skeleton. The tibiæ are, moreover, straight in both, and not of sabre form.

In twenty-four Australian skulls of both sexes, there was a mean weight of brain of 41·38 ounces, or a mean internal capacity of 81·1 cubic inches, while in eleven Tasmanian skulls of both sexes the mean cerebral weight was 42·25 ounces, or a corresponding cranial capacity of 82·8 cubic inches. From this it may be deduced that the Tasmanian excels the Australian in having a brain ·87 oz., or twenty-four grammes heavier, or an internal capacity of skull superior to the extent of 1·7 cubic inch. This squares with Dr. Topinard's observations.

This being the case, we should suppose that the inventive powers of the Tasmanians would exceed those of the Australians; but this, possibly owing to some extra stimulus to the invention of the latter race, is not the case. It seems, indeed, probable that it was the abundance of food in Tasmania which was the cause of the non-invention of two of the implements so necessary to the Australian when engaged in the chase, to wit, the "boomerang" and the "wommera," or throwing stick, by which spurs were hurled, both of which are indigenous to Australia, not being known elsewhere. The Tasmanian had, indeed, the "waddy," a short stick of hard wood, which they threw with a rotatory motion so as to kill a bird on a tree, but this was a far less elegant weapon than its Australian representative, the boomerang. As evidence that the invention of implements is not commensurate, wholly and simply, with cerebral development, we must bear in mind that the bow and arrow, so useful to the Asiatics, Pacific Islanders, and American Indians, was never discovered either by the Tasmanian or Australian.

A surprising deficiency among the Australian and Tasmanian tribes is a total absence of pottery, and this among many races that had no substitute in the pericarp of fruits. This is a hard fact for those who would fain believe in the derivation of Australian and Tasmanian from other races. In some parts of Australia where long drought has been suffered the natives have actually used the dried calvarium of a deceased person, cementing the sutures with a vegetable gum, upon which they stick the shell of an oyster to protect the resin from being rubbed off. The Tasmanians were further quite unacquainted with the shield. Nothing is so demonstrative of the complete isolation of the Tasmanians as the fact that, though separated from Australia by a strait but little more than 300 miles wide, there had been no intercommunication from either side between the two countries until the advent of Europeans. This fact tells strongly against those who believe in the almost universal spontaneous diffusion of races. The Tasmanians further had no native dogs, nor was the practice of circumcision known among them, facts tending further to prove the isolation of the two races. Neither this race, moreover, nor the Australians of the south, were in possession of boats, so that even the intermediate islands in the straits were quite uninhabited. There is reason, however, to believe that, like the Australians, some tribes of the Tasmanians were accustomed to punch out the front teeth. This rests only on osteological evidence, as no account has ever been given of the prevalence of the custom among this race.

Finally, "all that can be said with truth is that the Tasmanians are not Australians, they are not Papuans, and they are not Polynesians. Although they may present resemblances to some of these, they differ from them substantially and essentially." From this it may be concluded that the Tasmanians were one of the most isolated races of mankind which ever existed. They have been one of the earliest races to perish totally by coming in contact with Europeans, and "their record now belongs wholly to the past." J. C. G.

[1] The darkest.

[2] In a skull, however, of a male Tasmanian about thirty years o age, belonging to Dr. Davis, the prognathism, both mental and supra-alveolar, is greater than in that of an Australian youth about twenty years old.

THE KINEMATICS OF MACHINERY[1]

THE study of pure mechanism, a branch of kinematics, in general consists of the solution of the following problems:—Given the mode of connection of two or more points or bodies with each other, required their comparative motion, and conversely given their comparative motion to find their proper connection. Now the comparative motion of two points is determined, as laid down by Willis, when (1) the velocity ratio or the proportion which their velocities bear to each other, and (2) their directional relations, are known; the latter requiring for its complete determination (*a*) the angle between the directions compared, (*b*) the angle which the plane containing the two directions makes with a plane fixed in space, and (*c*) the angle the intersection of the two planes makes with a fixed line on the latter plane. In "Kinematics of Machinery," the English translation by Prof. A. B. W. Kennedy of Prof. Reuleaux's "Theoretische Kinematik,"[1] the study is confined within narrower limits, causing the translator not a little difficulty, as he expresses in his preface, to translate the word kinematic, carrying as it does a more extended signification here than on the Continent. Starting with the condition that the change of position is definite at each instant, and determined by the form and connection of the fixed and moving parts, Prof. Reuleaux proceeds to investigate the directional relations of the motion and the arrangements of the parts by which the motion is best brought about without any reference to the idea of velocity.

On turning to the Appendix, pp. 585–589, we find a most interesting historical collection of the definitions of

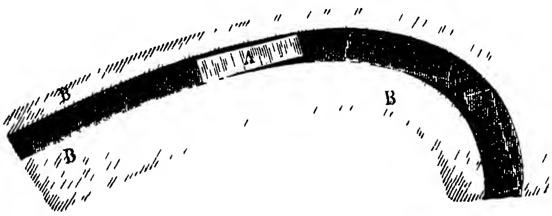


FIG. 1

a machine, one of which definitions we remark includes equally an adhesive fly-paper and the red-hot poker of the clown; that given by Reuleaux, p. 35, is more concise and certainly nearer the point than most of these. "A machine is a combination of resistant bodies so arranged that by their means the mechanical forces of nature can be compelled to do work accompanied by certain determinate motions."

Thus the prevention, by the resistance of the different parts, of all motion other than that desired, as well as the conversion into useful work of as much of the energy expended as its *efficiency* permits, is the function of the machine. "Those parts of a machine transmitting the forces by which the moving points are caused to limit their motions in the definite and required manner, must be bodies of suitable resistant capacity; the moving parts themselves must belong also to similar bodies." But the determination of the suitable form and sectional area of the resistant parts, though indispensable in the construction of the machine, belongs to another part of the study of machine design, and cannot be included in the kinematic discussion.

We now come to the conception of a pair of elements. In order that a body B (Fig. 1) may prevent all other motion in the body A than that desired, A being assumed to move in a plane, B must be given a form such that it always remains in contact with A in all its required positions; when that has been done no other motion can be given to A with respect to B. This geometrical form of B is called the envelope of A, and it is plain that the motion of B with respect to A, considered fixed, is the same as that of A with respect to B, and that no other motion of B with respect to A is possible; that is, A is also the envelope of B. The relation is thus seen to be reciprocal. A combination of this sort is called a pair of elements, and a machine consists solely of such elements, corresponding reciprocally in pairs. "The shaft and the bearing, the screw and the nut are examples of such pairs of elements. We see here that the kinematic elements of a machine are not employed singly, but always in pairs, or, in other words, that the machine cannot so well be said to consist of elements as of pairs of elements. If a kinematic pair of elements be given, a definite motion can be obtained by means of them if one be held fast or fixed in position. The other element is free to be moved, but only in the one particular way allowed by the constitution of the pair."

In order to combine two pairs of elements *a b* and *c d*, we must unite each element of one pair with one of the elements of the other pair. If this is effected as in Fig. 2, no new motion is obtained, as also when they are in the same straight line; but if *a* and *d* are united in such a manner as not to be parallel or in one straight line, the motion is entirely altered, and any points between *b* and *c* will describe a curve. In either of these two cases having united *a* to *d* and *b* to *c*, we have only two resistant bodies each limiting and determining the relative motion

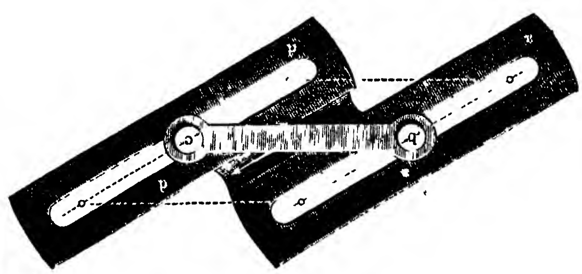


FIG. 2

of the other; thus the two pairs of elements are reduced to one pair, in one case with the same, in the other with a different motion.

"Accordingly, the reciprocal combination of the elements of two pairs gives us again a pair of elements which may differ from either of the single pairs of which it is composed." Again, a combination of three, four, or more pairs of elements may be made, each element of each pair being combined with one element of another pair, thus forming a linkage returning upon itself, or a so-called closed kinematic chain. Fig. 3 shows this combination. As a good example of this, the beam, connecting rod and crank of a beam-engine may be taken; *a* and *b* are the Plummer blocks of the crank shaft and main centre rigidly connected together by the bar *a h*, which represents in the engine the rigid connection of these two by the frame, supports, and bed; *b* the crank-shaft rigidly connected by the crank with the crank-pin *c*; *d e* the connecting rod rigidly connecting the crank pin *c* with the gudgeon *f*, and lastly, the beam *e h* rigidly connecting the gudgeon *f* with the main centre *g*. In this closed chain of four pairs of elements the only motions of each part with respect to *a h* regarded as fixed are readily seen. Thus we are led on to the result that "the mechanism is a closed kinematic chain; the kinematic chain is compound or simple, and consists of kinematic pairs of elements; these carry the envelopes required for the motion which the bodies in contact must have, and by these all motions

[1] "The Kinematics of Machinery: Outlines of a Theory of Machines." By F. Reuleaux, Director of and Professor in the Königlichen Gewerbe-Akademie in Berlin, Member of the Königl. technischen Deputation für Gewerbe. Translated and edited by Alex. B. W. Kennedy, C.E., Professor of Civil and Mechanical Engineering in University College, London. (London: Macmillan and Co., 1876.)

other than those desired in the mechanism are prevented." When one of the mechanical forces of nature, such as that of falling water, moving air, or expanding steam, is applied to one of the movable links in such a manner as to cause it to change its position, mechanical work is performed accompanied by certain determinate motions, and the whole is called a machine. The relative motion of two bodies in a plane is next considered, and the conceptions of the instantaneous centre and of centroids

FIG 3

introduced. At each instant of the motion in a plane of one body with respect to another considered as fixed, the motion can be accurately represented by a rotation in the plane about a fixed point, which, however, in each succeeding instant may occupy a different position; this point is called the instantaneous centre, and the positions it occupies in successive instants trace the centroid. Space will not permit us to show the formation of the reciprocal centroid, or how the motion of the moving body can be represented at each instant by the rolling on one another of the centroids, and the motion of any points connected rigidly with the moving body determined when the centroids are known, but the example given as illustrating the determination of relative motion from the known centroids will speak for itself. The centroids given are a circle and straight line which roll on each other. All points rigidly connected with the circle

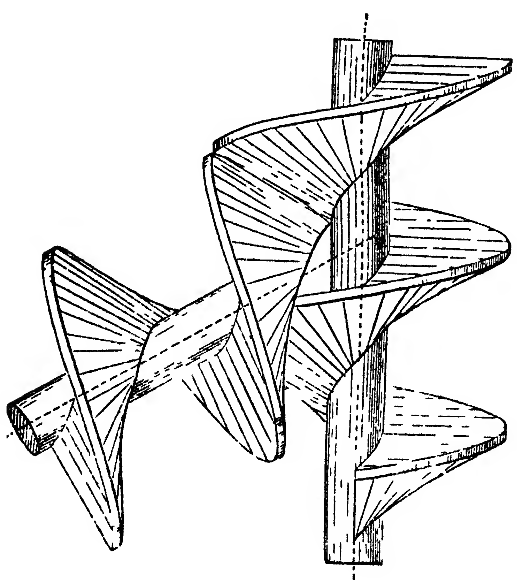


FIG 4

describe trochoids, the line being regarded as fixed; all points rigidly connected with the straight line describe involutes, the circle being considered fixed, and all these paths are determinate, and can be constructed if the position of the moving point with respect to the moving element, circle or line, and the centroids, the line and circle are given.

From motion in a plane and the determination of centroids, we pass to motion in space. If the position of three points in a rigid body not in the same straight line are known, the position of any other point in it may be determined from them, and if the three points are fixed in space the body is also fixed. Thus, to determine the relative motion of two rigid bodies in space, we have only to consider the motion of two triangles fixed one in each of them; or the motion of one triangle fixed in the moving body with respect to the other reduced to rest. The change of position of the moving triangle may take place in many ways, but it may in every case be effected by its translation parallel to itself in a line joining the old and new positions of one of its angular points, and then by a rotation about an axis through the new position of that angular point. Thus any change of position of a rigid body may be effected by a simple translation and a simple translation about an axis. The simplest case is when the translation takes place along a line parallel to the axis of rotation, when, if the change of position of the moving body be taken indefinitely small, the instantaneous axes of rotation along which sliding simultaneously takes place become indefinitely near each other; the motion is then a simple twist.

"Consider a pair of bodies having conical rolling, in which both cones have a motion of translation in space. The rotation then takes place through the conical rolling, and the sliding through the translation of the pair of bodies." Next "consider the consecutive positions of the axes as forming a pair of ruled surfaces, one for each body, so that the motion is reduced to the rolling of the two ruled surfaces upon each other with a simultaneous endlong sliding upon each other of the generators which are in contact. The surfaces of these solids being the loci of the axes, are called axoids. Thus all relative motions of two bodies may be considered as the twisting or rolling of ruled surfaces or axoids." The ruled surfaces roll on each other without sliding, when all the axes meet in a point as in a pair of cones or a cone and cylinder; also when the point of intersection is at any infinite distance, as in the case of two cylinders with parallel axes. These are, however, only particular and more obvious cases of the general condition of rolling without sliding, viz., that the two ruled surfaces are developable on each other.

APPARATUS FOR REGISTERING ANIMAL MOVEMENTS[1]

THE registering apparatus which have enabled us to carry so far the investigation of the functions in living animals are applicable to the analysis of movements of every kind in health and in disease. It is to this important application that I desire to draw your attention at the present time.

Most of the movements whose various phases we have to estimate must be transmitted to a distance, preserving at the same time all their characteristics. It is by the medium of the air that this transmission is effected, and its principle is as follows:—

Upon the organ (muscle, artery, heart) whose movements are to be investigated an apparatus called the exploring drum is applied. It is a small metal basin closed by a caoutchouc membrane, and communicating by a longer or shorter tube with a similar drum, upon the membrane of which is supported a recording lever. The pen with which the extremity of this lever is provided inscribes the curve of the movement impressed on the membrane of the first drum on a cylinder covered with smoked paper and turning on a horizontal axis.

1. Let us at once apply the process of analysis to the muscular movements of man. For this purpose we may either grasp the muscles of the ball of the thumb between the flattened jaws of the pincers which I show you, or apply to the fleshy substance of any muscle an exploring drum, the knob of which rests upon the muscle. When by means of electricity we cause a contraction or tetanus of the muscle to be studied, the curve of the contraction or that of the tetanus is recorded at a distance upon the revolving cylinder.

This apparatus shows the thickening which a muscle undergoes

[1] Paper read in the Biological Section at the Loan Collection Conferences, by Prof. Marey.

during contraction, and it furnishes results identical to those obtained by investigating the shortening of the muscle during contraction in living animals. We are then quite authorised to interpret in the same way the curves obtained in both cases.

It is needless to insist on the numerous services which the myography of man may render to physiology and medicine. The study of the forms of movement, of the latent period, of muscle, and perhaps even the rate of transmission of impulses along motor nerves, by means of this apparatus may be as easily pursued in healthy or unhealthy men as in animals.

2. Without quitting the investigation of muscular movements, let us examine that of the respiratory movements, and we shall obtain valuable information as to the means by which the important function of respiration is effected. We apply to the chest this apparatus formed of an elastic plate and furnished with two lever arms, to the extremity of which is attached a band which surrounds the thorax. Each dilatation of the chest causes the spring to bend, and it resumes its position during respiration. This double movement is accompanied by a rising and falling of the membrane of the drum which forms part of the apparatus, and which therefore becomes a regular bellows, causing the elevation and depression of the inscribing lever placed beside the cylinder.

The respiratory curves thus obtained present certain normal characteristics susceptible of being greatly modified when any obstruction interferes with the respiratory functions either by impeding the entrance or the exit of the air, or even by opposing its passage in both directions. In all these cases the curves have a special physiognomy, and their simple inspection enables us to recognise the seat of the obstacle to respiration. Clinical research will yet discover here many points for investigation.

3. But above all there are the phenomena of circulation, which have been minutely investigated both in man and animals. The apparatus by means of which we can completely analyse the movement of the heart, the arterial pulse, &c., have already rendered great service; we are, however, right in expecting yet more from it, by making use of it in clinical investigations.

Of various cardiographs, that on which I wish to dwell differs little from the explorer of which I have already spoken. The knob with which it is provided is applied to the region of the apex of the heart, and each beat of the organ is transmitted to the recording lever. There is seen in this pulsation of the heart the same elements which the physiological cardiograph has revealed in the higher animals. This beating of the heart is then a complex act, and the numerous details which have been discovered by graphic analysis have each a considerable importance from the point of view of functional investigation. One part of the tracing shows us how the ventricle is emptied into the artery; another enables us to appreciate the play of the auricle, the beating of the sigmoid valves, &c. You will easily see that the precise diagnosis of affections of the heart, already carried so far, thanks to auscultation, will be greatly improved by the application to man of the cardiograph applied to the study of the pulsation of the heart.

The arterial pulse cannot be separated from the pulsation of the heart in the study of the phenomena of circulation in man. Already numerous researches have been undertaken by means of the direct sphygmograph; but much more may be expected from the use of the air sphygmograph (*sphygmographe à transmission*).

I place this apparatus upon my wrist, and the artery raising a spring connected with the membrane of the exploring drum, transmits its movement to a distance by means of the tube filled with air, which enables this sphygmograph to communicate with the drum to which the recording lever is attached. By recording simultaneously the traces of the pulse and those of the heart much information may be obtained and many errors avoided.

4. I shall present to you, in conclusion, a new method of investigating the peripheral circulation. This method is based on the principle that the variation of the calibre of the blood-vessels in any part of the body is faithfully indicated by the variations of the volume of that part. Without dwelling on the history of these investigations, I may tell you that they originated many years ago, Dr. Piégu, of Paris, having pointed out in 1846 the alternate expansion and contraction of the tissues in connection with the dilatation and contraction of the blood-vessels. Since that time Chelius and Fick in Germany, Mosso in Italy, Franck at Paris, have carried on and extended these researches.

The recording of the movements of a column of water inclosed in a tube communicating with a receiver filled with water and into which the hand and forearm is plunged, was first effected by Fick by means of a float armed with a pen. Ch. Buisson hit on the happy idea of transmitting to a distance, by means of tubes filled with air, the oscillation of the column of water, and it is with his apparatus that M. Franck, in my laboratory, has executed a series of researches. You see the apparatus in action. The hand is plunged into this jar filled with water and hermetically closed. A vertical tube, furnished with a bulb to avoid the effects of the speed acquired by the liquid, serves to transmit to a recording lever the oscillation of the column of water. You will remark that these oscillations are rhythmical with the heart, and if we record them by the side of the cardiac pulse registered by the transmitting sphygmograph, we can establish the identity of the variations in size or, as we may term them, the pulsations of the hand and of the pulsations of a single artery. With this apparatus we may perform numerous experiments on the mechanical effects of compression of the arteries or veins, the action of the vaso-motor system of nerves, direct or reflex, &c.

I shall not explain to you by the side of this method of investigation, that which we owe to Mosso, of Turin His plethysmograph, which ought soon to be presented to you, permits the estimation of changes of volume of the hand, and, assuredly, the combination of these two processes ought to lead to important results in the investigation of the phenomena of peripheral circulation.

I have sought to submit to you some of the points more immediately applicable to man, without dwelling on the investigation of the movements among animals. But these two orders of researches complement each other. We may say that most of the data furnished by experimentation on animals are now susceptible of rigorous verification on man, healthy or unhealthy. This verification we owe to investigation by means of precise apparatus and to the recording of the smallest movements, thanks to the registering instruments, the principal specimens of which are shown in this Collection.

DREDGINGS OF THE "CHALLENGER"

PROF. WYVILLE THOMSON had not set foot long in Old England before presenting in person a preliminary quota of his results to the learned bodies. Two papers read by him at the Linnean Society on June 1, embodied observations on Echinodermata, a group to which, as is well known, he previously had paid much attention. One of the communications described some new living Crinoids belonging to the Apiocrinidæ. Of deep-sea forms the stalked crinoids are extremely rare, and have a special interest on account of their palæontological relations; it was therefore with satisfaction that near St. Paul's rocks at 1,850 fathoms, the trawl brought up, among other things, an entire specimen of a new crinoid, *Bathycrinus Aldrichianus*, and fragments of another, *Hyocrinus bethellianus*. At other stations and on different occasions, were obtained another species of *Bathycrinus* (*B. gracilis*) and an undetermined beautiful little species of *Hyocrinus*, besides examples of the *Rhizocrinus lofotensis* of Sars; all of these being referable to the Apiocrinidæ. In pointing out their structural peculiarities and alluding to *Bathycrinus*, he mentioned that the stem barely enlarges at its junction with the cup, the ring formed by the basals is very small, and the first radials are free from the basals and often free from one another, while the oral plates are absent. This genus appears to possess an assemblage of characters in some respects intermediate between *Rhizocrinus* and the pentacrinoid stage of *Antedon*. *Hyocrinus bethellianus* has much the appearance, and in some prominent particulars it seems to have very much the structure of the palæozoic genus *Platycrinus* or its sub-genus *Dichocrinus*. The stem is much more rigid than that of *Bathycrinus*; the cup consists of two tiers of plates only, the lower is to be regarded as a ring of basals, and the upper consists of fine spade-shaped radials. There are five arms which are pinnulated. The proximal pinnules are very long, running on nearly to the end of the arm, and the succeeding pinnules are gradually shorter, all of them, however, running out to the end of the arm. Distally the ends of the five arms, and the ends of all the pinnules meet nearly on a level. This arrangement is unknown in recent crinoids, although we have something close to it in species of the fossil genera *Poteriocrinus* and *Cyathocrinus*; with this, however, their resemblances end. *Rhizocrinus* finds its ally in the cretaceous genus *Bourgueticrinus*; *Bathycrinus* and *Hyocrinus* are evidently related to the former, but the characters of the Apiocrinidæ are nevertheless obscure in

the two latter. In his second paper Prof. Wyville Thomson drew attention to peculiarities in the mode of propagation of certain Echinoderms of the Southern Sea. He passed in review examples of the Sea-cucumbers (*Holothuroids*), Sea Urchins (the circular *Cidaroids*, and heart-shaped, *Spatangoids*), Star-fish (*Asteroids*), and the Brittle Stars (*Ophiuroids*). In allusion to their phases of development he stated the majority of these pass from the egg without the intervention of a locomotive pseudembryo. Among other data in support of this view he said, that while in warm and temperate seas "plutei" and "bipinnari" were constantly taken in the surface-net; yet during the southern cruise between the Cape of Good Hope and Australia, only one form of Echinoderm pseudembryo occurred, and which was considered with some little doubt as the larva of *Chirodota* from the presence of dermal, calcareous, wheel-shaped spicules. Furthermore Prof. Wyville Thomson described in detail the almost constant occurrence among the majority of the foregoing groups a curious, receptacular pouch wherein the young are carried until arriving at a certain maturity. This marsupium is situated on the dorsal portion of the body, is composed of a series of plates which meet centrally and permit of the young creeping about and returning to it for shelter. The young derive no nutriment from the parent while contained in the "nursery," other than it may be a mucous secretion.

THE U.S. WEATHER MAPS[1]

IN this fourth contribution to meteorology, Prof. Loomis discusses certain points of a miscellaneous nature which have been either very slightly or not at all examined in his three previous contributions. The movements of areas of high barometer, which are of so great importance in their relations to weather and climate, have been examined with the result that while the average track of areas of low pressure across the United States is nine degrees to the north of east, the track of areas of high barometer advance toward a point several degrees south of east, and with a velocity somewhat less than the former.

As regards the conditions under which the monthly minima of temperature occur, it is shown that these conditions, viz., winds very light, sky clear, and pressure above its mean height, are substantially the same at Jakutsk, Siberia, as at New Haven. Prof. Loomis is of opinion that it is true universally that periods of unusual cold are generally accompanied by a barometer above the mean, and by a descent of air from the upper regions of the atmosphere. These areas of high barometer have a broader significance than is here implied. It is the still, clear, and dry atmosphere accompanying them, *and its relations to terrestrial and solar radiation*, which afford the conditions of extreme temperatures. The monthly minima of the cold months of the year and the maxima of the warm months both frequently occur under the conditions afforded by areas of high pressure. On the other hand, in North-western Europe it is often observed that the minima of temperature during the warm months repeatedly occur within areas of low pressure where very light easterly and northerly winds prevail. In discussions of the relations of temperature and pressure, it is seldom kept steadily in mind that the given temperature is merely the temperature observed within a few feet of the earth's surface, which, as regards areas of high pressure, will nearly always mislead if it be used as a basis from which to estimate the temperature of the higher strata vertical to it; the surface temperature being abnormally low in winter from contact with the cooled surface, and in summer abnormally high from contact with the heated surface of the earth.

The examination of storm paths in America, the Atlantic, and Europe is important from the bearing of the subjects on climatology and weather-forecasting. Some interesting results of such an examination are given by Prof. Loomis in the average paths marked on the chart accompanying the paper. The results, however, are not calculated to be practically useful until the average paths be laid down for each month in the year, owing to the very great differences in these paths as regards different months. Thus, in North-western Europe, during the spring months, when east winds are most prevalent in Great Britain, many storm tracks, or the course of barometric depressions, are more southerly, and during the winter months more northerly than that indicated on the chart. If the track of storm-centres in winter generally took the line of The Channel, our winters would, on the average, be much more severe than they are, owing to the greater frequency of easterly and northerly winds, which would necessarily follow. But open winters are the rule in these islands, and even as far north as Faroe, where, during winter, southerly and westerly winds largely preponderate, thus showing that the central tracks of the majority of our winter storms lie to the north of Faroe. The exact determination of the average monthly tracks and the more marked deviations from them would throw light on several important questions affecting the climatology of the whole of North-western Europe.

Since the average velocity of storms over the United States as deduced by Prof. Loomis from 485 cases, is twenty-six miles per hour, and over the Atlantic, as deduced from 134 cases, is 19·3 miles per hour, and the average velocity of European storms as deduced by Prof. Mohn is 26·7 miles per hour, it follows that storms travel less rapidly over the ocean than over continents. If further inquiry confirms this result, we have here a valuable contribution to the theory of storms which will likely lead to a clearer insight into the causes which regulate their rate of propagation over the earth's surface, accelerating it in some cases, and in others retarding it as is frequently seen off the coast of Newfoundland and in the Bay of Biscay.

[1] Results derived from an examination of the United States Weather Maps and other sources. By Prof. Elias Loomis, Yale College. Fourth Paper. From the *American Journal of Science and Arts*, vol. xi., Jan. 1876.

NATURAL SCIENCE AT CAMBRIDGE

THE Cambridge Natural Science Tripos has just entered upon a new phase of existence. The recent examination is the first in which a division into two parts, elementary and advanced, is carried out, the former being held in June and the latter in December. Candidates who do not satisfy the examiners in the first part are not permitted to compete in the second. The final class-list is to be based on the alphabetical principle, but the first class will consist of two divisions, each arranged alphabetically, and the subject or subjects for which a man is placed in the first class are to be indicated, while a special mark will reward superior proficiency. This system removes some of the worst faults of the competitive system, and is of especial benefit to the more able men. One subject will not be pitted against another as regards marks, an accumulation of cramming in several subjects will not serve an inferior man, and clear testimony will be given that a man has a competent knowledge of a subject, or that he is specially proficient in it. With such arrangements, the value of the examination will largely depend upon the wisdom of individual examiners. It will be obvious that there should be at least two examiners in each subject instead of one. Also the pittance they receive should be transformed into fair remuneration, which will, no doubt, be done as soon as the University has more funds at its disposal.

It was to be expected that a new system, by which no man receives any credit in a subject unless he shows satisfactory knowledge of it, and by which the examination is limited to three days, would produce a large number of failures to attain honours. The number of candidates in June was forty-four, a large increase; of these only thirty-one obtained honours, while ten others received the ordinary degree. On scrutinizing the papers, it appears that there is a difficulty in equally adjusting the questions which probably have affected the result. Two questions in each subject, except human anatomy, are given in every paper; one question only is set in human anatomy, which is introduced for the first time. I will quote some of the questions in geology and in physiology, giving fair samples; and it will be plain that they are not equivalent in difficulty, and that students of moderate ability and reading might gain honours by answering the former much more easily than the latter.

"In which of the three great divisions of stratified rocks do fossils of the genera Ichthyosaurus, Phacops, Calamites, Voluta, Terebratula, Ostrea, and Micraster respectively occur?" "Volcanic rocks have been divided into two classes, acidic and basic. Give the name and mineralogical composition of a common rock of each

class." "To what conditions of deposit do fossils of the following groups of genera respectively point?—1. Unio, Paludina, and Cyrena. 2. Nautilus and Globigerina. Illustrate this by reference, in each case, to a British example."

"Explain what is meant by 'arterial tonus.' State generally what is the origin, course, distribution, and mode of termination of the nervous channels by which the brain and spinal cord influence arterial tonus." "Describe the rhythmical respiratory movements of the glottis in mammalian animals, referring to the mode of action of the most important muscles which are concerned in their production."

I only wish to point out the contrast in difficulty between the above sets of questions, without offering any opinion as to the suitability of either. In zoology and comparative anatomy the following question seems rather unusual for such an examination.—"Briefly describe the internal economy of a beehive, and the mutual relationships of its inmates." Here is a question in geographical distribution:—"In what countries are the following animals found—the orang utan, vampire-bat, tapir, leopard, elk, emu, and python? State what principles of zoogeography are deducible from their distribution." It seems to me that a knowledge of the distribution of all the more important species is far beyond the pass qualification for an honours' examination. In admitting men to such a qualification, tests should rather be applied which every student of a subject ought to be able to respond to; but it is questionable whether we can yet expect every student of zoology and comparative anatomy to "state concisely the doctrine of evolution as employed in biology."

It is not stated in how many subjects a candidate must pass in order to obtain honours; nor are any named as essential. There is a strong feeling that elementary chemistry and physics should be made compulsory on all, and that students should be allowed to present themselves in these subjects at an earlier period of their course.

G. T. BETTANY

NOTES

WE are glad to learn that upwards of 1,000*l*. has been subscribed towards the Chemical Society Research Fund, so that the Council are now in a position to accept Dr Longstaff's generous offer of 1,000*l*. to form a permanent fund. We only hope that the fund may still be largely increased.

THE Albert Medal of the Society of Arts for "distinguished merit in promoting Arts, Manufactures, and Commerce," has this year been unanimously awarded to Sir George B. Airy, K.C.B., the Astronomer Royal, for "Eminent Services rendered to Commerce by his Researches in Nautical Astronomy, and in Magnetism, and by his Improvements in the Application of the Mariner's Compass to the Navigation of Iron Ships." A prize of a Gold Medal was awarded to Mr. Hearson for the best "Revolution Indicator," which should accurately inform the officer on deck, and the engineer in charge of the engine, what are the number of revolutions of the paddles or screw per minute without the necessity of counting them. For papers read before the Society medals have been awarded as follows:—To Mr. Clements R. Markham, C.B., for his paper "On the Cultivation of Caoutchouc-yielding Trees," Mr. W. T. Thornton for his paper "On Irrigation Works in India," Mr. E. Hutchinson for his paper "On the Development of Central Africa," Mr. W. Valentin for his paper "On Dextrine-Maltose, and its use in Brewing."

MR. H. N. MOSELEY, M.A., has been elected to an Extraordinary Fellowship at Exeter College, Oxford, tenable for five years under a special ordinance sanctioned by the Visitor. Mr. Moseley, who was educated at Exeter College, proceeded to his B.A. degree in 1868, having obtained a "first class" in natural science in Trinity term of the same year. He was elected in 1869 Radcliffe Travelling Fellow, and has recently been one of the scientific staff of the expedition of H.M.S. *Challenger*.

M. WADDINGTON intends to establish Fellowships in the several French Academies in imitation of the Fellowships of the English Universities. The French Fellowships are to hold good only for a limited period, and will not be subject to the restriction of celibacy. The credits will soon be asked for from the French Assemblies.

IN the University of London D.Sc. Examination Mr. Thomas Carnelley and Mr. Frank Clowes have passed in Inorganic Chemistry, Mr. James Gordon MacGregor in Electricity (treated experimentally), Mr. Edward Bibbins Aveling in Vegetable Physiology, and Prasanna Kumár Ráy in Logic and Moral Philosophy.

ON Thursday last the master and other members of the London Clothworkers' Company visited Leeds, in order to inspect the working of the Textile Industries' department of the Yorkshire College of Science, which was founded and endowed by the munificence of the Company. The visitors expressed their satisfaction with the results of the endowment, and the master, Mr. Wyld, in replying to the toast of the Company, showed that he had an unusually high idea of the duties which devolved on the London Companies as trustees of the large funds which belonged to them. While placing a high value on technical education, moreover, he expressed the opinion that any special education divorced from, or not based on, wide general culture, would be defective and inefficient.

MR. LLOYD, the president of the trustees of the Fisk donation for the construction and fitting up of the San Francisco Observatory, arrived in Paris at the end of June. His first visit was to M. Leverrier, who gave him every assistance in his power to enable him to fulfil the object of his mission. Mr. Lloyd is at liberty to use the observatory grounds for any experiments in connection with his large refractor, which it is intended to construct. M. Leverrier concurred with him in not attempting to construct a lens of more than one metre in diameter. The money at the disposal of Mr. Lloyd is 200,000*l*. The law-suit is at an end, and the donation of a similar sum for the museum is cancelled, but the astronomical donation has been confirmed.

PROF. H. G. SEELEY has been appointed Professor of Geography at the Queen's College for Ladies, Harley Street.

THE Geologists' Association are to make an excursion to the North Wales Border on Monday, July 17, and five following days.

THE forty-second annual meeting of the Statistical Society was held on June 27, at the Society's Rooms, the President, Mr. James Heywood, F.R.S., in the chair. The report read showed that the Society continues to advance steadily in numbers and in public estimation.

WE have before us the commencing number of "The Proceedings of the Linnean Society of New South Wales," which contains papers by Mr. Brazier, C.M.Z.S., on a new species of Australian and Solomon Island shells; by Mr. Ramsay on a new species of *Ptilotis* from the Endeavour River, with some remarks on the natural history of the East Coast Range near Rockingham Bay, and by Mr. Maclean, the President of the Society, on a new species of *Dandrophis* from Cleveland Bay. We are convinced that a work so well commenced has the good wishes of all interested in the diffusion of science.

MR. ALEXANDER AGASSIZ, in his recent trip to Peru, found occasion to conclude that the Pacific, within a comparatively recent time, extended through gaps in the Coast Range, and made an internal sea which stood at a height of not less than 2,900 feet, and probably much above this. This is proved by the fact of the occurrence of coral limestone 2,900 or 3,000 feet

above the sea level, about twenty miles in a straight line from the Pacific. The corals are of modern aspect, although the species are undescribed. The fact that there are extensive saline basins at a height of even 7,000 feet on the coast of Peru would seem to indicate that the submergence was at one time still greater than that suggested. Indeed, eight species of *Allorchestes*, a salt-water genus of amphipod crustaceans found in Lake Titicaca, would seem to indicate that this lake, 12,500 feet above the sea, must have been at one time at the sea-level.

WE have received Part II. of vol. ii. of the *Transactions* of the Norfolk and Norwich Naturalists' Society. The Society, which has just completed its seventh year, has gradually been increasing in numbers, and there are now 150 members, many of whom are well known to the scientific world. The Society's efforts to carry out the objects for which it was established have been, on the whole, successful. Of the papers printed *in extenso*, a series of twenty letters forming a most interesting correspondence between Gilbert White and Robert Marsham, is by far the most important. This is rendered still more interesting by the valuable notes contributed by Mr. Harting and Prof. Newton. Of the other original papers, we may mention the Meteorological Report and the Ornithological Report, by Henry Stephenson, F.L.S. (author of the "Birds of Norfolk"); also the concluding portion of Mr. Geldart's list of the plants known to occur in Norfolk. The latter forms a portion (the sixth) of the Fauna and Flora of the County, which the Society is printing. Among the occasional notes and observations some interesting facts are recorded.

LIEUT. MINTZER, of the U.S. Navy, we learn from *L'Explorateur*, is organising a scientific expedition to the Arctic Seas, at Norwich, Connecticut.

A VERY destructive earthquake was felt at Corinth (Greece) on June 26, and another of the same date in Austria.

AT the Loan Collection during the present week, twelve demonstrations of apparatus were given on Monday, the same number on Tuesday, and six on Wednesday; four will be given to-day, four to-morrow, and ten on Saturday.

TWO handsome works have just been published by Masson of Paris—"Le Microscope, son Emploi et ses Applications," by Dr. J. Pelletan, with 278 figures and four plates, and "Traité d'Électricité Statique," by Prof. E. Mascart, two vols., with 298 figures.

PETERMANN'S *Mittheilungen* for June contains a considerably detailed account of the results of the discovery of Franz-Josef Land by the Payer-Weyprecht Expedition, founded on the work recently published at Vienna by Lieut. Payer. Accompanying the paper is the first satisfactory map yet published of the newly-discovered land, in which all the details of the sea and land are shown, as well as all the names imposed by the leaders of the expedition. Dr. Couto de Magalhães' "Travels in Araguaya" are concluded, and a brief synoptical summary is given of Walker's new statistical atlas of the United States.

THE Lindley Library, to which we referred last week (p. 200), does not belong to the Horticultural Society, nor was it bought by it. It was purchased with part of the surplus of the proceeds of the International Horticultural Exhibition and Botanical Congress held in London in 1866, and is vested in the hands of sundry trustees, who will be grateful for any donation. By permission of the Horticultural Society the library is deposited in its rooms.

THE twenty-eighth annual meeting of the Somersetshire Archæological and Natural History Society will be held at Bath on July 18, 19, and 20, under the presidency of Mr. Jerom Murch. Several excursions have been arranged.

THE first aquarium erected in Scotland was opened at Rothesay, in the island of Bute, last Thursday. The situation of the aquarium is in every respect favourable, and there is a large amount of tank accommodation, which has been arranged so as to contain both salt and fresh-water fish. The fresh-water tanks are perhaps the largest of the kind in the country, one of them containing over 20,000 gallons of water. A seal-pond is being constructed, and an eight-horse power engine sends the fresh and salt water from the reservoirs below to the tanks above. The reservoir for the former is capable of containing 90,000 gallons, while that for the latter has a capacity of 150,000 gallons. It is hoped that the aquarium will do good service as a school for practical natural history.

VARIOUS sanitary measures (according to Dr. Tholozan) have recently been adopted by the Turkish and Persian Governments with reference to the outbreak of plague, which commenced in Mesopotamia in the early part of the year. Since the beginning of March a sanitary *cordon* has been established on the north of the invaded territory, on the most frequented route of Kurdistan and Syria, between Tecrit and Kifri. On the south a quarantine of fifteen days is obligatory since April 1 on all vessels sailing on the Tigris and the Euphrates. It is at Kourna, at the confluence of these rivers. The ports of the Persian Gulf are protected by a quarantine which vessels from infected localities have to undergo at the island of Kezzer, formed by junction of the Chotel Aral and the Karoun. Since April 10 all communications by land between Persia and Mesopotamia are subject to a quarantine of fifteen days. For three years, it may be added, all pilgrimages into the infected country, by Persian subjects, have been interdicted. To fully comprehend this system of protection it should be remembered that on the west and north-west, for an extent of three degrees of latitude, no artificial barrier has been or can be established against the plague; but there are, happily, natural obstacles, which prove much more efficacious, the infected region being there bounded by the deserts of Syria and Mesopotamia. The greater rarity of communications there renders restrictive measures, on the arriving caravans, easier. Judging from past outbreaks of plague, it was anticipated that the present would decline in June (after reaching its *acme* in the end of May), and disappear from Mesopotamia in July. But it may send off-shoots to Bussora, Bouchéïe, and Arabistan, and a still greater danger is the introduction of germs of the plague into the high plateaux of Anatolia, Kurdistan, and Persia.

AN interesting addition to the literature of insectivorous plants is furnished by a reprint, by Casimir De Candolle, from the *Archives des Sciences Physiques et Naturelles*, "Sur la Structure et les Mouvements de Feuilles de *Dionæa muscipula*." With regard to the power of digestion, M. De Candolle comes to a conclusion opposed to that of Darwin, that the absorption of animal substances is not directly utilised by the leaves, and is not necessary to the development of the plant. He considers their anatomical structure favourable to the hypothesis that the movement of the two valves of the leaf results from variations of turgidity of the parenchyma of their upper surface.

A SINGULAR and useful society is in the way of formation at Paris. Seventy-two institutions of France have met in the Hotel of the rue de Grenelle to organize a general topographical association. Each institution becoming a member engages to prepare a topographical map of its commune, with roads, streams, mountains, &c. As the number of institutions in France exceeds 40,000, the number of registered adherents is very small indeed; but more are expected to join, especially if the Government takes interest in the association. The scientific value of such maps may not be great, but the result in the diffusion of geographical methods and promotion of knowledge is unquestionable.

CAPT. ROUDAIRE has delivered before the Geographical Society of Paris a lecture on the results of the survey of the Tunisian

Chotts. The measures taken last year on the Algerian side have been verified. The same level has been found for the connecting station with an immaterial difference of 2·80 metres in favour of the operation. The altitude at Gabes is only 46 metres, which is no obstacle to the channel being opened. Every objection raised by an Italian Commission has been set aside. MM. d'Abbadée and de Lesseps promised their help and testified their satisfaction.

THE half-yearly general meeting of the Scottish Meteorological Society will be held to-morrow. The business before the meeting will be—1. Report from the Council of the Society. 2. Notice as to observations of the velocity of the wind at different heights, by Thomas Stevenson, F.R.S.E., F.G.S. 3. Meteorological Register kept by James Hoy, at Gordon Castle from 1781 to 1827, communicated to the Society by His Grace the Duke of Richmond and Gordon, with remarks thereon by Mr. Buchan, secretary. This, we believe, is a very valuable register.

MR. E. F. FLOWER has published "A Sequel" to his much-needed pamphlet on "Bits and Bearing Reins." We are glad to see that his efforts to abolish the useless and cruel bearing-rein, and to introduce a rational and humane, and therefore scientific, way of managing horses has been largely successful. We cannot see how any man who wishes to be "merciful to his beast" can, after reading Mr. Flower's pamphlet, persist in the use of the bearing-rein, which after all is quite unnecessary, and no doubt tends to make a horse contract vices.

NOS. 4 and 5 of the *Iowa Weather Review* give a very good summary of the weather of the State of Iowa during December, January, and February last, dividing the season into nine decades. The winter was unusually mild, being 10°·5 above the average of Iowa winters, while during the third decade of December the excess rose to 19°·7. Less than an inch of rain fell in the north-west of the State, but in the central countries the fall was large, amounting to 9·60 inches at Davenport. Several interesting practical tables are added showing the days of thaw when the maximum exceeded 32°, days of frost when the minimum fell below 32°, and days of cold when the temperature fell to zero or lower. Sudden colds following in the wake of storms are also detailed, together with the barometric rise, and the velocity and direction of the wind, accompanying these great falls of temperature, which form so marked a feature in the climate of America. The alleged change of climate from the cultivation of the soil and the destruction of forests by which the summers, as stated, are becoming warmer and the winters colder, is a question which deserves to be carefully examined.

WE have received "Results of Meteorological Observations made at the Bath Royal Literary and Scientific Institution during the Ten Years ending February, 1875," by the Rev. Leonard Blomefield. The pamphlet, which is an extract from the "Proceedings of the Bath Natural History and Antiquarian Field Club," is a conscientious piece of work, evidently got up with the greatest care. The instruments appear to be fairly placed, except the rain-gauge, which is fixed in a faulty position, viz., at the top of a building. The monthly and yearly mean temperatures have been deduced from the 9 A.M. observations corrected for diurnal range, though it may well be doubted whether "*means*" can be calculated from observations made at only one hour of the day and whether any diurnal range corrections yet exist applicable to Bath. Some very interesting comparisons are drawn between the climate of Bath and other parts of England, with on the whole a just apprehension on the part of the author of the misleading nature of data when based on the observations of different years. Some of the differences, however, pointed out by Mr. Blomefield, such as the higher temperature of Bath as compared with Exeter during January and February disappear when a comparison is made from observations taken during the same years at each place, or from results obtained by the method of differentiation. Among the interesting results arrived at is the higher temperature of the river as compared with that of the air at Bath amounting to 2°·5 on a mean of the year, rising in June to 4°·6, and falling in February to 0°·5. In many respects the pamphlet is a valuable contribution to the meteorology of the south-west of England.

DR. H. HAMBERG, Assistant Professor of Meteorology at the University of Upsal, has written in the "Proceedings of the Royal Academy of Sciences," Stockholm, a very interesting paper on the development of the barometric minimum accompanying the thunderstorms which occurred in Sweden and Norway from July 14 to 20, 1872. From the data before him, Dr. Hamberg concludes that the barometer fell most where the sky was cloudless, and that the fall of heavy rain was generally attended with a rise rather than a fall of the barometer, much in the same way as Dr. Hann has shown to take place within the tropics at Batavia. The question is as difficult as it is important in meteorology, and the investigation of the behaviour of the barometer during our summer thunderstorms is likely to lead to most valuable results.

THE additions made to the Royal Aquarium, Westminster, during the past week are as follows:—A large collection of fresh-water fish, including Carp, Bream, Chub, Perch, Roach, and Trout, presented by the Earl of Aylesford; Sand-eels (*Ammodytes lancea*), Gemmeous Dragonettes (*Callionymus lyra*), Lump-fish (*Cyclopterus lumpus*), Five-bearded Rocklings (*Motella mustela*), Sea Bream (*Cantharus lineatus*), a shoal of young Lobsters (*Homarus vulgaris*), hatched in the tanks.

THE additions to the Zoological Society's Gardens during last week include eleven Lineated Pheasants (*Euplocamus lineatus*), nine Amherst Pheasants (*Thaumalea amherstiæ*), nine Gold Pheasants (*T. picta*) and two Peacock Pheasants (*Polyplectron chinquis*), bred in the Gardens; a Cape Buffalo (*Bubalus caffer*).

SCIENTIFIC SERIALS

THE January number of Reichert and Du Bois-Reymond's *Archiv* opens with the conclusion of L. Dittmer's lengthy communication on double monsters.—Carl Sachs describes and figures the terminations of nerve fibres in certain tendons.—In a long controversial article, Prof. Hitzig defends his own and Fritsch's conclusions with respect to the functions of the cerebrum against Hermann, Braun, Carville, and Duret.—F. Boll's article on the Savian vesicles found in the torpedo about the nasal orifices and between the external edges of the electrical organs and the limb-cartilages, is very interesting, because he demonstrates the existence in their epithelium of spindle-shaped cells corresponding in character to those so commonly found in special sense organs.—Dr. Colasanti, of Rome, gives an account of the results of section of the olfactory nerve in the frog. He finds that there is no consequent alteration in the nutrition or appearance of the olfactory cells or of the peripheral ramifications of the pale nerve-fibres.—Dr. Colasanti, in another short memoir shows that the fertilised hen's egg may be reduced in temperature to from − 7° to − 10° C. without its vitality being destroyed or in any way interfered with.—Rabl-Ruckhard contributes an elaborate account of the brain and cerebral nerves of the black ant (*Camponotus ligniperdus*).

The March number of the *Archiv* contains a very interesting account by P. Guttmann of his new experiments on respiration. Investigating the respiratory pause following on inspiration, he found that in vagotomised rabbits this pause does not occur. The possible reasons for this are discussed. In rabbits, in whom apnœa has been produced, it is always found that when the apnœa terminates, an inspiration, not an expiration, is the first phenomenon.—Bernstein and Steiner contribute an important paper on the transmission of contraction and the negative variation in the muscles of mammalia; but the intricacy of the sub-

ject does not admit of a brief abstract.—Another valuable paper on this subject, by Du Bois-Reymond himself, is commenced in this part. It constitutes the second part of his researches on negative variation of the muscular current during contraction, and must be consulted by all workers in this difficult branch of research.—Dr. Wenzel Grüber has five papers, some of considerable length, on various anomalous muscular dispositions. Such papers should be condensed as much as possible.

THE two last numbers of the *Nuovo Giornale Botanico Italiano* are chiefly occupied with Italian botany.—Among papers of more general interest we have a description by A. Mori, of the structure of the wood of *Periploca græca*; and two by Prof. Caruel:—On the flowers of *Ceratophyllum*, in which he describes the peculiar contrivance for the fertilisation of the female flowers, the rigid leaves apparently serving as the channel of transport for the pollen; and observations on *Cynomorium*, in which several points in the structure of the flower are detailed, and the author gives his adhesion to Dr. Hooker's suggestion of a possible genetic connection between Balanophoreæ and Halorageæ.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, March 15.—The first article is by Prof. Tomaschek, of Brünn, on mean temperatures as thermal constants for vegetation. The law, formerly pointed out by him, of the dependence of the commencement of blooming, on the height of daily mean temperatures, appears not only not to be shaken, but to be supported by an investigation of the results for the exceptional year 1862.—The next article is by Dr. Hann, on the results of observations on Mount Washington and Pike's Peak. During very cold weather, the change of temperature with height is less than usual, amounting only to about 0·3° C. for each 100 metres, so that the equilibrium of the air vertically must be at such times very stable. The mean decrease with height in the dry climate of Pike's Peak is somewhat greater than in the Alps and at Mount Washington. The daily and monthly ranges are excessive on the elevated plains. Dr. Hann greatly regrets the impracticable form in which the reports have been published, considering the desirability of having the actual observations for Pike's Peak and Colorado Springs, two stations better situated for meteorological purposes than any others in the world, accompanied by the proper data and corrections, which are here wanting.—In the Kleinere Mittheilungen we find a description of Redier's self-registering barometer.

Journal de Physique, February.—This number commences with the first part of a paper by M. Jamin, describing his recent researches on magnetism. He gives an account of his methods of observation, offers some theoretical ideas on the nature of magnetism, and discusses magnetic conductivity and distribution in a thin plate.—In a note on meteorology applied to agriculture, M. Marié Davy gives some interesting tables with reference to changes observed in wheat at different dates (the relation of transpired water to the temperature and actinometric degree, the weight of constituent substances, proportion of nitrogen in stalk, &c.). He considers that by the end of May or beginning of June, according to locality, one may generally deduce from meteorological data the probable value of the coming harvest, save in the case of exceptional perturbations, whose injurious action is circumscribed.—M. Duter investigates the distribution of magnetism in circular and elliptical steel plates.

Gazzetta Chimica Italiana, 1876, fascicolo ii.—This part commences with a paper by G. Pisati in continuation of former researches entitled:—On the elasticity of metals at different temperatures. In this paper the author treats of the elasticity of torsion at various temperatures of wires of silver, iron, steel, copper, brass, gold, platinum, and aluminium. The apparatus employed is figured, and the results shown in many cases graphically by means of curves.—On the production of ozone during the evaporation of water, by G. Bellucci.—The modifications of starch in plants, by M. Mercadante.—Synthesis of propyl-isopropyl-benzene, preliminary note by E. Paterno and P. Spica. This hydrocarbon, of which the formula would be $C_6H_4 \left\{ \begin{array}{l} C_3H_7 \\ CH_2.C_2H_5 \end{array} \right.$ has been prepared by the action of zinc ethyl on cumene chloride. It is a liquid a little lighter than water boiling at about 205°—208°. Other hydrocarbons boiling at a high temperature are also produced during the reaction. The authors propose to continue their researches.—The absence of leucine in the product of the germination of graminaceæ, by M. Mercadante.—The remainder of the part is devoted to abstracts of papers from foreign sources.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 15.—"Researches illustrative of the Physico-Chemical Theory of Fermentation, and of the conditions favouring Archebiosis in previously Boiled Fluids." By H. Charlton Bastian, M.A., M.D., F.R.S., Professor of Pathological Anatomy in University College, London, and Physician to University College Hospital.

The author first calls attention to the fact that no previous investigator has professed to have seen well-marked fermentation set up in urine that had been boiled for a few minutes, if it has thereafter been guarded from contamination. The previous invariable barrenness of this fluid after boiling has been ascribed by germ-theorists to the fact that any organisms or germs of organisms which it may have contained were killed by raising it to the temperature of 212° F. (100° C.).

In executing some of the experiments with urine described in this communication, two chemical agents have been brought into operation under novel conditions, and an ordinary physical influence has been employed to an entirely new extent. In several respects, therefore, these new experiments differ much, as regards the conditions made use of, from those hitherto devised for throwing light upon the much-vexed questions as to the possible origin of Fermentations independently of living organisms or germs, and as to the present occurrence or non-occurrence of Archebiosis.

The chemical agents employed under new conditions in these experiments were *liquor potassæ* and *oxygen*—both of them being well known as stimulants, if not as promoters, of many fermentative processes.

It has been recognised by several investigators of late years that neutral or slightly alkaline organic fluids are rather more prone to undergo fermentation than slightly acid fluids. This fact may be easily demonstrated. As the author pointed out in 1870, if two portions of an acid infusion are exposed side by side at a temperature of 77° F. (25° C.) fermentation may be made to appear earlier and to make more rapid progress in either of them by the simple addition of a few drops of liquor potassæ; on the other hand, if a neutral infusion be taken and similarly divided into two portions placed under the same conditions, fermentation may be retarded, or rendered slower in either of them at will, by the simple addition to it of a few drops of acetic or some other acid.

A neutral or faintly alkaline organic solution can in this way be demonstrated to possess a higher degree of fermentability than an otherwise similar acid organic solution. It seems, therefore, obvious that the changes capable of taking place in *boiled* acid and neutral solutions respectively should also vary considerably. Numerous experiments by different observers have demonstrated the correctness of this inference. Boiled acid infusions guarded from contamination mostly remain pure and barren if kept at temperatures below 77° F. (25° C.), though other infusions similarly treated and similar in themselves, except that they have been rendered neutral by an alkali, will oftentimes become corrupt and swarm with organisms. The latter result follows still more frequently with neutral infusions when they are exposed to a higher generating temperature in the warm-air chamber; and under this stronger stimulus a small number of boiled acid fluids will also ferment.

On the other hand, the influence of oxygen in promoting fermentation has been fully appreciated since the early part of the present century. Formerly an influence was assigned to it as an initiater of fermentation as all-important as some chemists assign to living germs at the present day. But this was a very exaggerated view. In some fluids, as the author has shown, fermentation may be initiated just as freely, or even rather more so, in closed vessels from which the air has been expelled by boiling, as in others in which atmospheric air, and consequently oxygen, is present. The explanation of this fact is probably to be found in the supposition that, in starting the fermentation of these fluids, diminution of pressure may be of as much, or even of more importance than contact with free oxygen. In respect to other organic fluids, however, the influence of oxygen seems decidedly more potent as a co-initiater of fermentation than that diminution of pressure which is brought about by hermetically sealing the vessel before the fluid within has ceased to boil. Urine will be found to be an example of this latter class of fluids.

The physical influence which has been employed in unusual intensity in the present researches is *heat*.

Previous experimenters have never designedly had recourse to a generating or developing temperature above 100° F. (38° C.). The heat employed has frequently been below 77° F. (25° C.), though a temperature between this and 95° F. (35° C.) has been regarded both by chemists and biologists as most favourable to the occurrence and progress of fermentative changes generally.

Early in the month of August, 1875, the author ascertained the fact that some boiled fluids which remained barren when kept at a temperature of 77°–86° F. (25°–30° C.) would rapidly become turbid and swarm with organisms if maintained at a temperature of 115° F. (46° C.). More recently he has discovered the surprising fact that a generating temperature as high as 122° F. (50° C.) may be had recourse to with advantage in dealing with some fermentable solutions. Fluids which would otherwise have remained barren and free from all signs of fermentation have, under the influence of this high temperature, rapidly become turbid and corrupt. This discovery is regarded as of great importance in reference to the questions now under discussion, and it is one which was quite unexpected. The author had previously shared in the generally received opinion that temperatures above 100° F. (38° C.) were likely to impede rather than promote fermentation.

In maintaining the experimental fluids at the high temperature above-named, the vessels containing them were placed in the hot-air chamber of an incubator, such as physiologists employ, to which one of the very ingenious gas-regulators of Mr. F. S. Page had been fitted (see *Journal of the Chemical Society*, January, 1876). In this way the fluids may be kept at a known and practically constant temperature for an indefinite time.

Liquor Potassæ as a Promoter of Fermentation in Boiled Urine.

In the autumn of 1875 the author instituted some experiments to ascertain whether the fermentability of boiled urine, like that of many other fluids, could be increased by previously mixing with it a quantity of liquor potassæ sufficient for its neutralisation.

The experiments answered this question in the affirmative. It was found that urine to which the above-named amount of liquor potassa had been added, would constantly ferment and swarm with organisms within a few days after it had been boiled; though some of the same stock of urine in the acid state (that is, without the addition of any alkali) would when similarly treated in other respects, remain barren. The fact of the production of an increased fermentability in boiled urine by previous neutralisation was thus established.

Further experiments were then instituted to throw light upon the cause of such increased fermentability. It was desirable to ascertain whether (1) it was due to survival of germs in the boiled neutralised fluid, or (2) to the chemical influence of potash in initiating or helping to initiate the molecular changes leading to fermentation in a fluid devoid of germs or other living matter.

The mode of testing the relative validity of these rival interpretations seemed easy. It was only necessary to ascertain what the effect would be of adding boiled liquor potassæ, in proper quantity, after the acid urine had been rendered barren by boiling it instead of adding it previous to the process of ebullition. If fermentation occurred in the fluid thus neutralised without extraneous contamination, the first interpretation would obviously be negatived.

This crucial experiment was at first tried with flasks plugged with cotton-wool, the plug in each of them being penetrated by a closed glass tube containing the measured amount of liquor potassæ. The tubes having been drawn out to a capillary portion at the lower end, and bent at an obtuse angle, they could be easily broken by slight downward pressure against the bottom of the flask whenever it was desired to mix the liquor potassæ with the boiled urine. This apparatus was very similar to that first made use of by Dr. William Roberts in some experiments with hay-infusion (Phil. Trans. vol. clxiv. p. 474), in which he obtained opposite results from those now about to be recorded with urine. The latter fluid is, however, for several reasons more suitable than hay-infusion for trying such experiments.

Several trials made with urine in this apparatus showed that its fermentability was just as much increased by adding boiled liquor potassæ after the urine had been boiled in the acid state, as by adding the alkali previous to the process of ebullition. Such a result was therefore quite opposed to the first interpretation as to the cause of the increased fermentability of neutralised urine.

The definite overthrow or establishment of this interpretation was so important that it seemed desirable to try such experiments again by some more rigid and certain method. The author, therefore, devised a new mode of experimentation in which scaled retorts replaced the flasks plugged with cotton-wool, and in which the contents of the enclosed liquor-potassæ tubes could be more effectually heated.

It was first of all ascertained that accurately-neutralised urine boiled in a retort and sealed whilst boiling, would ferment in a day or two if kept at a temperature of 122° F.[1]

This fact having been established, other retorts were charged with a measured amount of urine, and also with a small glass tube containing liquor potassæ in quantity almost sufficient to neutralise the urine employed.[2] The glass tubes containing the liquor potassæ had been drawn out at one end, sealed, and then immersed in boiling water for different periods before introducing them into the retorts. After each retort had been charged with urine and a liquor potassæ tube, its neck was drawn out to a capillary point, the urine was boiled, and the retort was hermetically sealed before ebullition had ceased. Thus closed, the vessel was at once immersed with its neck downwards in a can of boiling water for from four to fifteen minutes, so as to expose it and its contents for an additional period to a temperature of 212° F. (100° C.).

The urine was thus boiled in its unaltered acid state and sterilised. After the retorts had cooled the liquor potassæ was liberated from its tube in all but one of the batch, which was kept as a control experiment. The liberation was easily effected. It was only necessary to give the retort a sudden shake so as to drive the capillary neck of the enclosed tube against its side. The tube was thus broken and immediately (owing to the comparative vacuum within the retort) the liquor potassæ was sucked out and mixed with the fluid which it was destined to neutralise.

The result of these experiments was similar to those executed with the plugged flasks and liquor-potassæ tubes. The boiled caustic potash added afterwards within the sealed retorts, caused the previously barren fluids to ferment and swarm with *Bacteria*. The fluid in the control experiment remained pure, though after several days, or longer, it also could be made to ferment by breaking the liquor-potassæ tube, and replacing the retort in the warm chamber.

Effects of liberating Oxygen by Electrolysis within the Closed Retorts. A few other experiments were made with retorts to which platinum electrodes had been fitted. These contained, as before, measured amounts of urine, together with liquor potassæ tubes. All the preliminary stages were similar to those of the experiments above recorded; but just before breaking the liquor-potassæ tubes in these further experiments, oxygen and hydrogen were liberated from the boiled urine by electrolysis.

The result in the few experiments made was very remarkable. Under the combined influence of liquor potassæ, oxygen, and the high temperature of 122° F. (50° C.), the sterilised urine fermented and swarmed with *Bacteria* within the closed retorts in from 7–12 hours—that is, in a much shorter time than would suffice for the occurrence of similar changes in unboiled urine freely exposed to the air.

Behaviour of some Specimens of unaltered Acid Urine under the influence of the High Generating Temperature of 122° F. (50° C.).

In the course of the previous experiments it was found that occasionally a specimen of boiled urine would ferment at a temperature of 122° F. without the addition of liquor potassæ. This was afterwards ascertained to occur invariably (with the urine experimented upon) when the acidity of the fluid was not higher than would be represented by six minims of liquor potassæ to the ounce (or about 1½ per cent.). Urines slightly more acid than this sometimes did and sometimes did not ferment without liquor potassæ; but when the acidity exceeded what would be equivalent to two per cent. of liquor potassæ, the fluid did not ferment under the influence of the high generating temperature alone. Urines of all degrees of acidity, however, were found to ferment under the combined influence of heat and liquor potassæ added afterwards, in the manner already detailed.[3]

[1] Though the boiled urine will ferment in retorts from which the air has been expelled by boiling, it will undergo this change more quickly if it is in the presence of purified or sterilised air. In the experiments now about to be described, however, it was much more convenient to use airless retorts.

[2] As a slight excess in the amount of liquor potassæ has been proved to have a most restrictive influence when dealing with urine, it was found safer in these experiments not to provide liquor potassæ sufficient for full neutralization. Many details on this subject are given in the memoir itself.

[3] In the urine of highest acidity with which experiment has been made, twenty minims of liquor potassæ to the fluid ounce (about 4 per cent.) was required for neutralisation.

It was further ascertained that the acidity of some specimens of urine was lessened during the process of ebullition (owing to the deposition of acid phosphates); and such urines boiled for six minutes were found to ferment in a much shorter time than when they were only boiled for three minutes. The prolongation to this extent of the germ-destroying temperature actually hastened the subsequent process of fermentation.

Interpretation of Results.

The generally received belief that all *Bacteria* and their germs are killed by exposing them even for a minute or two to the temperature of 212° F. (100° C.) has of late been strongly reinforced by Prof. Tyndall. The fact, therefore, of the fermentation of some specimens of boiled acid urine, with the appearance of swarms of *Bacteria*, under the influence of the high generating temperature of 122° F. (50° C), is inexplicable except upon the supposition that fermentation has in these instances been initiated without the aid of living germs, and that the organisms first appearing in such fluids have been evolved therein.

If the author's further position (Proceedings of Royal Society, Nos. 143 and 145, 1873), that *Bacteria* and their germs are killed in fluids whether acid or alkaline at a temperature of 158° F. (70° C.), is correct, then the occurrence of fermentation in the previously neutralised boiled urine would similarly disprove the exclusive germ-theory of fermentation and establish the occurrence of Archebiosis.

Any difficulty which might have been felt by others in accepting the above interpretation of the results of these latter experiments—in face of the view held by M. Pasteur that some *Bacteria* germs are able in neutral fluids to survive an exposure to a heat of 212° F. (100° C.)—has been fairly met and nullified by the experiments (devised for the purpose), in which the urine was boiled in the acid state and subsequently fertilised by the addition of boiled liquor potassæ.

If we look at these latter experiments from an independent point of view, it will be found that this fertilisation of a previously barren fluid by boiled liquor potassæ must be explained by one or other of three hypotheses:—

1st Hypothesis. The boiled liquor potassæ may act as a fertilising agent because it contains living germs.—However improbable this hypothesis may seem on the face of it, it has been actually disproved by many of the experiments recorded in this memoir. These experiments show that boiled liquor potassæ will only act as a fertilising agent when it is added in certain proportions. If it acted as a mere germ-containing medium, a single drop of it would suffice to infect many ounces, a gallon, or more of the sterilised fluid. This, however, is never the case; it only fertilises the barren urine when it is added in a proportion dependent upon the precise acidity and quantity of the fluid with which experiment is being made.

2nd Hypothesis. The fertilising agent may act by reviving germs hitherto presumed to have been killed in the boiled acid urine.—The acceptance of this hypothesis would involve a general recantation of the previously received conclusion that *Bacteria* and their germs are killed by boiling them in acid fluids. But such a recantation would be scarcely justifiable or acceptable unless based upon good independent evidence.

The possibility, however, of accepting this second hypothesis is still further closed by the results of experiments in which a slight excess of liquor potassæ was added to the boiled urine. Such fluids invariably remained barren. Yet it can be easily shown that the mere development and growth of *Bacteria*-germs may take place both quickly and freely in boiled urine containing a very large excess of liquor potassæ.[1] It would seem that this agent mixed with boiled urine in quantity slightly more than is needed for neutralisation, prevents the *origination* of living matter therein, although even when in considerable excess the same agent affords no obstacle to the development, growth, and multiplication of germs purposely added thereto.

In the face of these facts it would seem impossible to accept this second hypothesis, even if it had not been independently negatived by the great mass of evidence—lately reinforced by the experiments of Prof. Tyndall—to the effect that *Bacteria* and their germs are really killed in fluids raised for a few minutes to the boiling-point (212° F.).

3rd Hypothesis. The fertilising agent acts by helping to initiate chemical changes of a fermentative character in a fluid devoid of living organisms or living germs.—If the cause of the fermentation of the fluids in question does not exist in the form of living organisms or germs either in the fertilising agent itself or in the medium fertilised, then it must be found in some chemical reactions set up between the boiled liquor potassæ and the boiled urine.

[1] A mixture of one part of liquor potassæ to seven of boiled urine poured into a bottle which has been washed with ordinary tap-water will, within forty-eight hours, swarm with *Bacteria* if it is kept at a temperature of 122° F.

The experiments in which liquor potassæ is added to urine in definite proportions before and after it has been boiled with the result of inducing fermentation in the otherwise barren fluids, as well as those in which unaltered urine ferments under the influence of the high generating temperature of 122° F. (50° C.), all alike, therefore, point to the same conclusion. They show, as other experiments have done, that an exclusive germ-theory of fermentation is untenable; and they further show that living matter may and does originate independently during the progress of fermentation in previously germless fluids.

As a result of the fermentative changes taking place in boiled urine or other complex organic solutions, many new chemical compounds are produced. Gases are given off, or these with other soluble products mix imperceptibly with the changing and quickening mother-liquid, in all parts of which certain insoluble products also make their appearance. Such insoluble products reveal themselves to us as specks of protoplasm, that is of "living" matter. They gradually emerge into the region of the visible, and speedily assume the well-known forms of one or other variety of *Bacteria*.

These insoluble particles would thus in their own persons serve to bridge the narrow gulf between certain kinds of "living" and of "dead" matter, and thereby afford a long-sought-for illustration of the transition from chemical to so-called "vital" combinations.

Zoological Society, June 20.—Prof. Flower, F.R.S., vice-president, in the chair.—The Secretary exhibited a drawing of a fine species of Fruit-Pigeon of the genus *Carphophaga*, living in the Society's Gardens, which apparently belonged to *C. paulina*, Bp. of Celebes and the Sulu Islands.—Mr. Sclater read extracts from letters received from Signor L. M. D'Albertis and Dr. George Bennett, respecting M. D'Albertis' proposed new expedition up the Fly River, New Guinea, and exhibited a small collection of bird skins made at Yule Island and on the adjoining coast of New Guinea, by the last-named naturalist.—Dr. A. Gunther, F.R.S., read a letter from Commander W. E. Cookson, R.N., respecting the large tortoises obtained in the Galapagos Islands which had been recently deposited in the Society's Gardens by Commander Cookson. The living specimens had been obtained in Albemarle Island, those obtained in Abingdon Island having died before reaching this country. Dr. Gunther added some remarks on the specimens of tortoises and other animals collected by Commander Cookson, and promised a more detailed account on a future occasion.—Mr. G. E. Dobson read a paper on peculiar structures in the feet of certain species of mammals by which they are enabled to walk on smooth perpendicular surfaces, especially alluding to *Hyrax* and the bats of the genus *Thyroptera*.—A communication was read from Dr. J. S. Bowerbank, F.R.S., being the sixth part of his monograph of the silicio-fibrous sponges.—A communication was read from the Rev. O. P. Cambridge containing a catalogue of a collection of spiders made in Egypt, with descriptions of new species and characters of a new genus.—A communication was read from Mr. W. T. Blanford containing remarks on the views of A. von Pelzeln as to the connection of the faunas of India and Africa, and on the mammalian fauna of Tibet.—A second communication from Mr. W. T. Blanford contained remarks on some of the specific identifications in Dr. Günther's second report on collections of Indian reptiles obtained by the British Museum.—Mr. Howard Saunders read a paper on the *Sterninæ* or Terns, with descriptions of three new species, which he proposed to call *Sterna tibetana*, *Sterna eurygnatha*, and *Gygis microrhyncha*.—Dr. Cunningham, of the University of Edinburgh, described a young specimen of a dolphin, caught off Great Grimsby, in September, 1875. After pointing out the great difficulty experienced in referring it to its proper place amongst the dolphins—this difficulty arising chiefly from the unsatisfactory and even unreliable descriptions which have been given in this country by former observers—he came to the conclusion that he was justified in referring it to *Delphinus albirostris*, the differences being, in his opinion, merely those of age.—Mr. J. W. Clark read some notes on a dolphin lately taken off the coast of Norfolk, which he was likewise induced to refer to the same species.—A

communication was read from Mr. R. B. Sharpe, containing the description of an apparently new species of owl from the Solomon Islands, which he proposed to call *Ninox solomonis*.—Mr. A. H. Garrod some notes on the anatomy of certain parrots.—Mr. H. E. Dresser read the description of a new species of broad-billed sandpiper, from North-Eastern Asia, to which he gave the name *Limicola sibirica*.—A second communication from Mr. Dresser contained the description of a new species of *Tetraogallus*, discovered by Mr. Danford in the Cilician Taurus, which he proposed to call *T. tauricus*.—Dr. A. Günther read some notes on a small collection of animals brought by Lieut. L. Cameron, C.B., from Angola.—A communication was read from Lieut. R. Wardlaw Ramsay, giving the description of a fine new species of Nuthatch from Karen-nee, which he proposed to call *Sitta magna*.

Meteorological Society, June 21.—Mr. H. S. Eaton, M.A., president, in the chair. The following papers were read:—On the climate of Scarborough, by F. Shaw. The thermometers used were placed in a louvre-boarded case fixed to the north side of a wooden structure, having an open grass plot in front of them. The garden is about midway between the north and south sides of the town, and 150 yards from the shore; and as both residents and visitors are continually passing along this line, the observations may be taken as fairly representing the temperature of Scarborough as a watering-place. The mean monthly temperatures based on the average of the past eight years are:—

Jan., 38°·8	April, 46°·6	July, 60°·4	Oct., 48°·2
Feb., 39°·7	May, 50°·5	Aug., 58°·9	Nov., 42°·2
Mar., 41°·6	June, 55°·9	Sept., 55°·1	Dec., 39°·0

The mean for the year is 48°·1.

The maximum temperature on any day in July, the warmest month, does not exceed on the average, 78°·0; the highest in the eight years being 85°·5 in 1868. The mean of the extreme minimum temperature in the eight Januarys is 24°·2; the lowest being 13°·3, which occurred on January 1, 1875. The moderate and agreeable summer temperature is due to the close proximity of the town to the sea, which in the warmest month of the season is about 5° below that of the air. The autumn and winter temperatures are also much influenced by the sea on the one hand, and the shelter afforded by the surrounding hills on the other. The sea is about 5° warmer than the air in the autumn, and 3° in the winter, while the prevailing winds are south-westerly and not felt in their full force. The annual rainfall, on the average of the past ten years, is 28·29 inches, which falls on 167 days.—Notice of upward currents during the formation and passage of cumulus and cumulo-stratus clouds, by Rev. J. Crompton. On Nov. 1, 1866, the day after the visit of the Prince and Princess of Wales to Norwich, when the city was profusely decorated with flags, the author, when walking close to the cathedral, was struck with the unusual fluttering of the flags on the top of the spire, which is 300 feet high. They were streaming with a strained, quivering motion, perpendicularly upwards. A heavy cloud was passing overhead at the moment, and as it passed the flags followed the cloud and then gradually dropped into comparative quietness. The same phenomenon was noticed several times. As the cloud approached, the upper banners began to feel its influence, and streamed towards it against the direction of the wind, which still blew as before, steadily on all below; as the cloud came nearer the vehement quivering and straining motion of the flags increased, they began to take an upward perpendicular direction right into the cloud, and seemed almost tearing themselves from the staves to which they were fastened; again, as the cloud passed they followed it as they had previously streamed to meet its approach, and then dropped away as before, one or two actually folding over their staves. All the other flags at a lower elevation did not show the least symptom of disturbance.—Suggestions on certain variations, annual and diurnal, in the relation of the barometric gradient to the force of the wind, by Rev. W. Clement Ley. The author finds that the mean velocity of the wind corresponding to each gradient is much higher in summer than in winter. This is the case at all stations (though not equally) with all winds, with all lengths of radius of isobaric curvature, and with all values of actual barometric pressure. The general character of the mean diurnal variations of velocity, as these occur at the stations in the British Isles, may be fairly inferred from mean horary velocity curves, and may be thus described:—At the inland stations, in summer, a slight increment of velocity occurs about midnight. This is succeeded by the morning minimum, which takes place in most of the months examined a little after sunrise. The mean velocity then rises until 1 P.M., when the diurnal maximum is sometimes attained. A slight subsidence then commonly occurs, but the mean velocity rises again at 3 or 4 P.M., and this second increment frequently forms the diurnal maximum. A great fall then takes place, which is more rapid than the rise in the morning; and the evening minimum, which is in most months the diurnal minimum, is attained about 10 P.M. The mean velocity at 1 P.M. is, in fine and hot weather, more than double the 10 P.M. velocity in miles per hour, and exceeds the diurnal mean by about one-third. In winter the inflexions are very greatly modified. The midnight rise is not in all months traceable, and the subsequent diminution is not very great. The morning maximum occurs about sunrise. The diurnal maximum takes place about 1 P.M., is less than double the minimum in miles per hour, and exceeds the mean of the day by about one-fifth only.—Average weekly temperature of thirty years (1846-75) at Cardington, by John Maclaren.—De la vulgarisation par la presse des Observations météorologiques, by M. Harold Tarry.

Physical Society, June 10.—Prof. G. C. Foster, president, in the chair.—Mr. W. J. Wilson exhibited and explained a reflecting tangent galvanometer which he has recently designed for the purpose of exhibiting the indications of the instrument to an audience, and so arranged that the divisions on the scale show without calculation the relative strengths of different currents. It should be observed at the outset that this object cannot be attained by attaching a mirror to the needle as in the ordinary galvanometer, as the angle passed over by the reflected ray is double that through which the needle is deflected. In the arrangement exhibited, the beam of light after passing through a small orifice traversed by cross wires, is reflected vertically by a fixed mirror: the ray then passes through a lens, and is again reflected from a small plane mirror parallel to the first, which is rigidly fixed below a small magnetic needle. By this means the ray becomes again horizontal, and, since the light now falls on the second mirror always at the same angle, the extent of motion of the ray is identical with that of the needle, and, if the scale be one of equal parts placed in the magnetic meridian, the indications on it will be proportional to the tangents of the angles, and therefore to the strengths of the currents. The needle and mirror are suspended by a silk fibre, and a bent strip of aluminium, the ends of which dip into water in an annular trough, is attached to the needle in order to check its oscillations. A series of observations taken with varying resistances introduced into the current, showed that the indications are very reliable.—Mr. S. P. Thompson then exhibited an electromotor clock made by Mr. W. Hepworth, of York, and provided with a commutator of Mr. Thompson's design. This part of the instrument is very simple, and reverses the current at each single oscillation by means of two light springs resting on inclined planes. The motion of the pendulum drives the train of wheels by a modification of the gravity-escapement, and a very small battery-power is sufficient.—Prof. G. Fuller, C.E., exhibited and described his "electric multiplier," an instrument which may be looked upon as an automatic electrophorus. An insulated plate of vulcanite is supported in a vertical position, and on each side of it is an insulated metallic plate, and these can be moved together to and from the vulcanite by rotating a handle. When these plates are far apart, two metallic arms provided with points are made to pass one on each side of the vulcanite plates. One of these is insulated, and is provided with a rod terminating in a knob, which at a certain point in its path almost touches the metallic plate on the opposite side of the sheet of vulcanite. The other arm is in connection with the earth. The action of the instrument is as follows. A charge of, say, negative electricity, having been given to the insulated arm, it is passed over its face of the vulcanite, while positive is drawn up from the earth and thrown upon the opposite face by the uninsulated series of points. These arms are then removed, and the two metallic plates are brought into contact with the vulcanite. Call the side of the plate charged with negative electricity A, and the other B. The negative of A induces positive on the near face of its metallic plate and repels the negative. This passes, by a strip of tin-foil joining the two faces of the vulcanite, to the other metallic plate neutralising its free positive, and when the plates are moved away from the vulcanite, that from A is charged with positive, and that from B with negative. Before reaching its extreme position this latter

communicates its charge to the insulated arm by the brass knob, the electricity is then distributed over the face A. At the ... of its path B is momentarily connected to earth. It will be evident that the effect of again bringing the plates in contact is to increase the charge of positive electricity on the metallic plate opposite the face A. With the small model exhibited, Prof. Fuller has frequently obtained sparks an inch in length.—Prof. Guthrie then exhibited and employed Prof. Mach's apparatus for sound reflexion, which is one of an interesting series of appliances designed by him for the demonstration of certain fundamental principles in physics. It consists of a mathematically elliptical tray, which is highly polished and provided with a close-fitting glass cover. The tray is covered with pulverised dry silicic acid, and a Leyden jar frequently discharged between two small knobs at one of the foci, when the silicic acid arranges itself in fine curves around the other focus.

Entomological Society, June 7.—Prof. Westwood, president, in the chair.—Messrs. A. A. Beiens, A. H. Swinton, and C. M. Wakefield were elected ordinary members.—Mr. Douglas made some further remarks on the "Corozo Nuts," known as "Vegetable Ivory," exhibited by him at the last meeting, which were attacked by a beetle of the genus Caryoborus. Mr. McLachlan, in connection with the above, exhibited the nuts of a species of Caryoborus (*C. bactris*) forwarded to him by Prof. Dyer. In this case each nut served as food for a single larva only, which bored in it a cylindrical hole of considerable size and depth; whereas the former nuts were infested with several larvæ in each nut.—The President exhibited the larva of an Australian species of Hepialus, from Queensland, bearing a singular fungus, with four or five branches issuing from the back of the neck and the tail; also a fungus growing out of the back of a Noctua pupa.—Mr. McLachlan, on behalf of Dr. Atherstone of South Africa, exhibited a couple of very singular Orthopterous insects (belonging to the Acrydiidæ), which in colour and in the granulated texture so exactly mimicked the sand of the district as to render it almost impossible to detect them when at rest. The insect was supposed to approach the *Trachyptera scutellaris*, Walker.—The President read descriptions and exhibited drawings of two very singular forms of Coleoptera from Mr. A. R. Wallace's private collection. For the first, which belonged to the Telephoridæ, he proposed the generic name Astychina, remarkable for the form of the terminal joints of the antennæ in one sex, which were modified with what appeared to be a prehensile apparatus, differing from anything known in the insect world, but of which some analogous forms were found to occur among certain Entomostracous Crustacea. The other pertained to the Cleridæ, and was named Anisophyllus, differing from all known beetles by the extremely elongated branch of the ninth joint of the antennæ.—Mr. Smith read descriptions of new species of Hymenopterous insects from New Zealand, collected by Mr. C. M. Wakefield.—Mr. J. S. Baly communicated descriptions of new genera and species of Halticinæ.—Dr. Sharp communicated descriptions of a new genus and some new species of Staphylinidæ from Mexico and Central America, collected by Mr. Salvin, Mr. Flohr, and Mr. Belt.—Part I. of the Transactions for 1876 were on the table.

PARIS

Academy of Sciences, June 19.—Vice-Admiral Paris in the chair.—The following papers were read:—Theorems relative to curves of any order and class, in which are considered couples of rectilinear segments having a constant product, by M. Chasles. Experimental critique on glycémia (continued), by M. Cl. Bernard. He illustrates these three points:—1. Sugar is rapidly destroyed in the blood after its extraction from the vessels. 2. Within the vessels, after death, sugar disappears rapidly. 3. In the living animal, the saccharine richness of the blood oscillates constantly.—On the cause of the movements in Crookes's radiometer, by M. Govi. He rejects the idea of an impulsive force of light, and of thermal currents of gas in the receiver; the causes he assigns being the dilatation by heat, or condensation by cold, of gaseous layers which all bodies retain at their surface, even in an absolute vacuum. It should be possible to obtain insensible radiometers, by heating the vanes, during the action of the mercury pump. M. Fizeau said the constant motion, for as long as an hour, of a radiometer placed in the centre of a circle of candles, was against this hypothesis.—Examination of new methods proposed for finding the position of a ship at sea, by M. Ledieu.—On the existence of mercury in the Cevennes, by M. Leymerie. In 1843 he had evidence that liquid mercury had been met with near a village at the foot of the Jurassic plateau of Larzac, was injurious to vegetation, was used to cure sheep disease, &c.—The plague in 1876; prophylactic measures, by M. Tholozan.—M. Pasteur presented a work entitled "Studies on Beer: its Maladies, and their Causes; Process for rendering it Unalterable, with a New Theory of Fermentation."—Influence of temperature on magnetisation, by M. Gaugain. Allevard steel and Sheffield steel undergo nearly the same *permanent* modification when subjected to the same alternations of temperature, but the *temporary* modification is much greater for the Sheffield steel than for the other. The coercive force is diminished by variations of temperature. The inductive action of a bobbin diminishes when the temperature increases.—Extension of the principle of Carnot to electric phenomena; general differential equations of the equilibrium of the movement of any reversible electric system, by M. Lippmann.—Letter to M. Dumas on experiments on the use of sulphide of carbon and sulphocarbonates, by M. Delachanal.—A letter from MM. Weyprecht and Wilczek was read, explaining their project for scientific exploration of the arctic regions.—Differential electro-actinometer, by M. Egoroff. Two of Edmond Becquerel's actinometers are arranged one above another in a common box, so that the current of the one is neutralised by that of the other, and a mirror galvanometer is interposed in the circuit. Each actinometer is a parallelopipedal box of glass with two opposite sides of hardened caoutchouc, and slits with silver plates in them. The outer box has slits to correspond, the width of which can be varied. The absorbing body to be studied is placed between the light and the slit corresponding to one of the actinometers, and the galvanometer noted when one and when both of the actinometers are in action.—Researches on the commercial analysis of raw sugars, by MM. Riche and Bardy.—On a new class of colouring matters, by M. Lauth. The first source of these has been the aromatic diamines obtained in reducing the nitrated derivative of acetylic combination of organic bases.—On some derivatives of isoxylene, by M. Gundelach.—On the spirophore, an apparatus for recovery of the asphyxiated, especially for drowning persons and new-born infants, by M. Woillez. (We notice this elsewhere.)—Graphic study of movements of the brain, by M. Salathé. Into an orifice of the cranium is inserted a glass tube, with caoutchouc stopper above, traversed by a smaller glass tube, which is connected with a lever and drum arrangement (of the Marey type). Water is poured in till it reaches about the middle of the small tube; its oscillations (from the brain surface) affect the registering lever. Among other results, the respiratory oscillations, observed simultaneously in the brain and the vertebral column, are synchronous. Artificial respiration reverses the order of oscillations, the liquid rising in inspiration, falling in expiration. Attitudes have a great influence. In efforts of any kind the oscillations are much increased.—Contractile vacuoles in the vegetable kingdom, by M. Maupas. The contractile vacuole has been regarded as a characteristic of animality. But various recent facts are against this. M. Maupas describes contractile vacuoles he has found in macrospores of the algæ, *Microspora floccosa*, Thuret, and *Ulothrix variabilis*, Kutzing (both in Algeria).—The mineral of nickel, in New Caledonia, or "Garnierite," by M. Garnier.—On nitrated alizarine, by M. Rosenstiehl

CONTENTS

THURSDAY, JULY 13, 1876

THE UNIVERSITY OF MANCHESTER

I.

WE have already alluded to a recent movement for procuring a University Charter for the Owens College, Manchester. While this took its origin in the teaching staff of the college, it has now, we believe, spread beyond these limits, and is at present engaging the earnest attention of the governing body of that institution. A pamphlet, drawn up by the members of the senate, and embodying their views, has likewise been sent to some of the most eminent men of the country, and replies have been received on the whole decidedly favourable to the object.

Under these circumstances we may be pardoned an attempt to discuss, however imperfectly, the present state of the higher education of this country, and to point out in what direction, and according to what principles, an improvement of the system may, in our opinion, most properly be brought about.

We shall therefore begin by a definition. Let it be understood that when we use the word University, we mean an institution in which, as far as training is concerned, the higher education of the whole man is contemplated. Now this means more than mere intellectual training—far more than mere intellectual instruction—for it means such a training as will turn out a man of high cultivation in all his powers—one able to take a leading part in the progress of his race. Such a cultivation has a four-fold aspect, moral, intellectual, social, physical. It may perhaps be giving undue prominence to this latter element, to insist upon the neighbourhood of a considerable river as a *sine quâ non* in founding a University, but this is only an extreme expression of the views entertained, we doubt not, by the authorities of Oxford and Cambridge, that a University should contemplate the physical training of its undergraduates, as well as what we call training in its higher forms. If these be the true functions of a University, it is almost superfluous to say that such an institution, in common with everything possessing vitality, must be constantly reforming itself, so as to adapt its training to the ever-varying and ever-advancing requirements of the age; and it is most certainly the part of a wise Government to consider how far the present institutions of our country meet its educational wants, and if they do not, to consider whether they cannot with propriety do something to supply these legitimate requirements.

Now this at once leads us to ask in the first place, What are the most distinguishing characteristics of the present age, or rather, perhaps, in order to limit our inquiry, of the British citizen of the age? what are, in fine, the essential conditions which the statesman must not ignore, but by which he must consent to be guided in all his attempts to legislate on the question?

In the first place, he cannot ignore what may be termed the religious difficulty. Perhaps, roughly speaking, about half the inhabitants of the country may be regarded as attached more or less to the Church of England, while the other half differ more or less widely from the tenets of that Church. Here it is evident that this difference of opinion does not imply any want of interest in religion, but the very reverse. What it does indicate is the line that must be pursued in all future legislation on the subject. The statesman must deal with men as they are, and in consequence of this difference he cannot afford, and indeed he will not attempt, to place the higher education of the country in the hands of one religious body, however powerful, whether this be the Church of England on the one hand or the positivists on the other. Such a policy may have been possible, perhaps even desirable, a couple of centuries ago, but it is neither possible nor desirable now.

In the next place, the statesman cannot ignore the fact that certain branches of knowledge and their applications have developed of late years in a very wonderful manner, so as almost to fix a new epoch in the progress of our race. The present is eminently the scientific age of the world.

Again this wonderful progress of scientific knowledge has added greatly to the wealth of the nation, especially in its larger centres of industry, and there is in consequence a very persistent and most praiseworthy cry for increased facilities for higher cultivation. Nor is this cry limited to scientific culture alone, in which case it would be less praiseworthy; but it embraces general cultivation, having, however, especial reference to these recently-developed branches of knowledge which have made our great cities what they are, and in which progress is necessary to a continuance of their well-being.

Now these inevitable conditions are not merely destined to regulate all future steps that may be taken for the spread of higher education, but they have already modified the position of the present institutions of our country, and besides this they are even now determining the action of Government in a variety of ways. The increased endowment of research, the loan collection of scientific instruments, and other developments which these will inevitably bring about, are indications that our present rulers are very much alive to the true welfare of the country. We are, however, here engaged rather with the future of the higher education, and we shall now show in what manner the principles we have dwelt upon have already modified our existing Universities.

To make this clear, let us begin by a brief description of the chief Universities of England and Scotland, and for this purpose we may confine ourselves to the two great English Universities, the four Scotch Universities, and the University of London.

The two great English Universities have come down to us from a time when the people of England practically thought alike on religious matters. Until recently these institutions bore all the marks of this ancient unity, inasmuch as they only gave their degrees and Fellowships to members of the Church of England. But it is well known that by recent enactments, not only degrees, but Fellowships may be held by those who are not members of the national Church. Nevertheless, while open to all, these Universities yet retain an especial relation to the Church of England, and we believe there is no widespread wish to see the connection violently altered.

In many respects these Universities are institutions

of great excellence, while in some respects they are altogether unique. In principle they embrace a very complete system of culture, in practice, however, it is found that their system is more especially adapted to the wealthier classes of the community. Judging of a tree by its fruits, we must not forget what a brilliant galaxy of statesmen, divines, philanthropists, and men of the highest general culture, have owed their training to these great Universities. It is when we come to strictly scientific professions, such as medicine and chemistry, that the deficiencies of these institutions begin to appear; neither Oxford nor Cambridge has turned out an appreciable number either of distinguished physicians or distinguished chemists. Those who are desirous to become proficient in these branches of knowledge almost invariably go elsewhere. The same may perhaps be said of the science of engineering.

It has been proved a great misfortune to the country that these two Universities have unwarrantably neglected the scientific training of their graduates. Nor is it untrue to say that in the past generation they have produced statesmen of unquestionable eminence, but yet profoundly ignorant of the scientific requirements of their country. It is only now, after a somewhat prolonged agitation, that the minds of the rulers of this country are becoming awake to the paramount value of science in the development of our resources.

Let us now briefly consider the four Universities of Scotland These institutions educate a far larger proportion of the people of Scotland than Oxford and Cambridge do of the English people. They are the training-schools rather of the middle than of the upper classes of the community. They excel in those branches in which Oxford and Cambridge are deficient, and they are deficient in those respects in which Oxford and Cambridge excel. Good medical men and men of good acquirements in various branches of science are produced by these Universities, but the accomplished scholar or mathematician is not produced—at least to any great extent. Nor, so far as we are aware, is any attention given to the physical training of the undergraduates. The Scotch Universities are not now connected with the Established Church of Scotland, except in the fact that there is a theological faculty attached to each of them, and that the Church of Scotland looks to that faculty alone for the theological training of its ministers. They are in the habit, however, of giving theological degrees with praiseworthy impartiality to eminent divines in all the somewhat numerous divisions of the Presbyterian Church, and occasionally to English Nonconformists.

The University of London is different from all these, inasmuch as it is entirely unconnected with any religious denomination. It had its origin, if we mistake not, in the wish to give degrees to those who, from adverse circumstances, had been unable to receive a University education, but who were yet possessed of the requisite information implied in a degree.

At the present moment a large number take advantage of this institution, and we believe that nearly 700 candidates presented themselves at the recent matriculation examination. Of these, however, the great majority are not unattached students, but are probably connected with some metropolitan or provincial college that has not the power of granting degrees. Thus the University of London is at present the degree-giving body for the alumni of a considerable number of colleges scattered throughout the country, and in virtue of this position it has a very great influence in regulating the studies at those institutions.

We have thus briefly described the present position of the higher education of this country, and it remains to consider in what respect the present system is deficient and how this deficiency may be remedied, consistently, of course, with those conditions which we have stated, and which no legislation can possibly ignore. This, however, must be reserved for a future occasion.

GALILEO AND THE ROMAN COURT

Galileo Galilei und die Römische Curie. Von Karl von Gebler. (Stuttgart, 1876. London: Trubner and Co)

THIS work supplies a continuous and detailed narrative of the circumstances under which Galileo incurred the hostility of the dominant party at Rome at the opening of the seventeenth century, and was by their influence denounced to, and ultimately tried and condemned by, the supreme tribunal of the Inquisition. An Appendix contains the text of the principal documents referred to in the body of the work. The whole forms a volume of rather more than 400 pages.

Such an undertaking, though it may, at first sight, appear a mere piece of surplusage to those who know how extensive is the already existing Galileo literature, is yet abundantly justified by recent events. Within the last ten years' original documents published in France and Italy, and German critical researches based upon them, have completely overthrown the view hitherto held by the most competent writers on this subject, and compelled the adoption of a diametrically opposite conclusion. All previous narratives of the trial of Galileo are thus necessarily superseded, and its history must be entirely re-written. Without attempting to explain the nature of the evidence which has brought about this change of view, a task much beyond my present limits, I propose to state wherein the change itself consists, and to what extent the opinions hitherto held concerning the conduct of the prisoner and of the Court are affected by it.

The essence of the charge against Galileo was, as we learn from the sentence finally pronounced, that after having been formally prohibited by the Inquisition from defending the Copernican theory, he had, in his Dialogues on the two rival systems of the universe, openly contravened this order, and so committed a clear act of contumacy, or, as we should call it, contempt of Court. On the question whether the accused had actually defended Copernicanism in his Dialogues, modern writers were able to form an independent judgment by the study of his incriminated work; but the statement about the injunction personally laid upon him by the Inquisition rested solely on the assertion of the Court itself, unsupported by one tittle of corroborative evidence. It is therefore a remarkable circumstance, and no bad illustration of how much may be done by strong asseveration, that the best historians, including some by no means antecedently inclined to repose a child-like confidence in the veracity of the Holy Office, one and all accepted its statement

on this decisive point as representing an undoubted historical fact. As Galileo's advocacy of Copernicanism was indisputable, the gratuitous admission of the second premiss of the Court necessarily also involved its conclusion, viz., that it had a right to punish the philosopher for his transgression of its command. Such accordingly was the practically unanimous verdict of historians.

Up to 1867 no portions of the proceedings in the case, except the sentence and form of recantation, had been made public in a trustworthy shape; but in that year M. de l'Epinois was permitted by the Roman authorities to publish *in extenso* the greater part of the original trial-record preserved in the archives of the Inquisition. A mass of fresh evidence thus became generally accessible, and was further increased by the publication in 1870, by Prof. Gherardi, of a second set of original documents bearing on the trial. It now became possible to check the statements of the tribunal by reference to the documents which it employed, and to the defence and depositions of the accused. This was done by Dr. Emil Wohlwill, of Hamburg, who, in a pamphlet published in 1870, showed that such a comparison led straight to the conclusion that the personal injunction asserted and relied on by the Inquisition had never been actually delivered to Galileo. Wohlwill supports this position by a mass of corroborative testimony extracted, with singular acuteness and ability, from Galileo's works and letters, and thus renders his case perfectly irresistible. These new results, striking and interesting as they obviously are, have attracted but little notice on the Continent, and an account of them given by me in a Friday evening lecture at the Royal Institution[1] constitutes, I believe, the only public attention they have received in this country.

As the charge advanced against Galileo was, after all, only formal and technical, his exoneration from it will hardly be considered as affecting in any considerable degree the estimate hitherto formed of his conduct in the matter, except indeed by those persons who consider unhesitating obedience to the will of a Roman Congregation as the duty of every right-thinking man. Unfortunately too, the nature of his answers under examination must influence opinion more considerably in an unfavourable direction. Not only did Galileo deny on oath having ever held the Copernican doctrine; he actually offered to write another Dialogue in refutation of the arguments in favour of the condemned tenet to be found in his former work, and protested his belief in the old Ptolemaic hypothesis as "most true and indubitable." Much allowance ought unquestionably to be made for an infirm and terror-stricken old man, but, even so, there remains an amount of really gratuitous insincerity on which it is painful to dwell, though it would be disingenuous to pass it over in silence.

As to the course pursued by the condemning tribunal, there can be little or no doubt that it deliberately lent itself to perhaps the most nefarious practice of which a judicial body can be guilty, namely, the admission of evidence known both to be false and to have been fabricated for the express purpose of securing a conviction which could not be compassed by fair means. The theological antagonists of the Holy Office have, no doubt, over and over again charged it with atrocities of this and of every other description, but I know of no instance save the present in which it has been convicted of such an enormity out of the mouth of its own records.

[1] On May 8, 1874.

Thus much of introduction appeared indispensable in order to define the point of view from which the volume in hand is written. Herr von Gebler regards the conclusions of Wohlwill as so firmly established, that his duty as an historian is no longer to discuss or defend them, but to weave them, together with the previously known facts of the case into a succinct narrative arranged in the order of time. Even to summarise the contents of his volume would be to attempt a fresh Life of Galileo. All that can be done here is to draw attention to a few of the salient incidents as they are presented in Von Gebler's pages.

It would seem that it was the Jesuits who, from beginning to end, were responsible for the persecution of the philosopher; and, most unfortunately for him, he quitted the service of the only State in Italy which could have enabled him to defy their machinations at the very time when its protection began to be urgently needed. Oppressed by the amount of lecturing and teaching incumbent upon him as Professor at Padua, and anxious, as it would seem, to illustrate in his own person the benefits to be derived from the "endowment of original research," Galileo applied for, and after some negotiation obtained, the post of first Mathematician about the person of the Grand Duke of Tuscany, which he hoped would secure him uninterrupted leisure for the prosecution of investigation and discovery. Von Gebler comments as follows on this calamitous step:—

"In spite of all the great advantages which this new post brought him, Galileo made a thoroughly bad exchange when he quitted the free territory of the Venetian republic in order to commit himself to the doubtful protection of a sovereign who, though personally very well disposed towards him, was young, vacillating, and, moreover, completely under the control of Rome. It was essentially the first step in the course which led Galileo towards his doom. Complete freedom of teaching existed actually in the Venetian Republic; nominally only in Tuscany. In Venice politics and science appeared guaranteed against Jesuit intrigues, for when Paul V. had thought fit to lay the uncompliant Republic under an Interdict (April 13, 1606), the Fathers of the Society of Jesus had to submit to immediate and permanent expulsion from its territory. In Tuscany, on the other hand, where the Order was thoroughly at home, its mighty influence lay heavy on all that touched its interests, and especially therefore on politics and science. Had Galileo never forsaken the fresh healthy air of the Free State, in order to breathe a close Rome-infected Court atmosphere, he would, there is every reason to believe, have escaped the subsequent persecutions of Rome, inasmuch as that same republic which, but shortly before, had not allowed itself to be intimidated by the papal excommunication pronounced against its Doge, its Senate, and its entire Government, would assuredly not have delivered up one of its University professors to the vengeance of the Roman Inquisition."

The period of private controversy during which the question at issue between the old and the new astronomy was forced, against the wish of Galileo, from a scientific to a theological mode of discussion, is very fully described by our author, who gives many amusing instances of the

ludicrous manner in which the Aristotelian philosophers attempted by *à priori* logical considerations to disprove the reality of the celestial appearances revealed by the telescope, and "as by magical enchantments to conjure them out of the heavens." So far as the *truth* of the Copernican theory was concerned, these individual skirmishes were put an end to by the peremptory decree of the Index Congregation (March 5, 1616), which reduced the revolutionary theory, for all Roman Catholic astronomers, to the level of a mere hypothesis, convenient indeed for the representation of phenomena, but not corresponding to actual external facts. This, the undoubted scope of the decree, which has escaped most previous writers, is carefully stated by von Gebler. The point is one of much interest, since the repressive attitude then taken up was not finally abandoned until as late as 1820. Two hundred years of astronomical research were needed to break down the unyielding Papal *non possumus*.

The appearance in 1632 of Galileo's Dialogue on the Ptolemaic and Copernican systems was the signal for the final catastrophe. Its high significance is well brought out in the following extract:—

"The book contains far more than the title promises, for the writer has, in connection with his discussion of the two great systems of the universe, introduced a record of almost every important result obtained by him during nearly fifty years of scientific research and discovery. The author shows himself determined to adopt a style which should appear not exclusively calculated for scholars, but, on the contrary, intelligible and even highly attractive for every really educated man. The essential object of the book was to spread abroad as widely as possible a clear recognition of the constitution of nature in its absolute and final form. That this object was so successfully achieved is attributable not merely to Galileo's philosophic, but, in the first instance at least, perhaps even more to his literary eminence. The external form of the work was in itself most happily chosen. There is not a trace of the dryness of a systematic treatise in which proof succeeds proof with a wearisome monotony, hardly relieved by a single pause. On the contrary, the facile lively form of dialogue so tolerant of digression, gave the author full opportunity to develop his impetuous eloquence, his singular power of reasoning, his biting satire—in short, his special and brilliant style."

Next let us observe the effect of the work on the enemies of its author:—

"Galileo, as one of the most momentously effective of pioneers, was in a high degree obnoxious to the Jesuits, and members of the order had repeatedly been signally worsted in scientific conflicts with the great philosopher, a circumstance by no means fitted to dispose the Fathers of the Society more favourably towards him. As soon as they recognised that in his latest work he had employed an immense array of facts and an overwhelming force of argument for the destruction of the fundamental principles of the old school, in order to build up with an inexorable logic the modern edifice upon its ruins, the Jesuits set all their levers to work to secure the suspension of the revolutionary book, and later, to bring about the ruin of its dangerous author. A prosecution before the Inquisition was their most convenient, indeed probably their only possible weapon."

The notion, still entertained by some writers, that nothing really serious was meant by the trial, but only the settlement of a point of ecclesiastical etiquette, is totally dispelled by the evidence stated in von Gebler's narrative. We see Galileo completely panic-stricken on first receiving the summons of the terrible tribunal, endeavouring in every possible way to keep out of its grip, and only finally complying when the Court had actually issued its writ to have him brought up to Rome *in irons*. We see the Grand Duke of Tuscany writing autograph letters to the Cardinals who were members of the Holy Office, begging for a favourable consideration of his servant's case. We see the Pope himself in a fit of ungovernable fury against Galileo;—fury so intense that the Florentine Ambassador, who had provoked it by defending the philosopher, precipitately dropped the subject, "lest he too should be charged with heresy by the Holy Office." During the slow progress of his case in Rome, Galileo was unquestionably treated with quite exceptional favour, in being allowed to reside in the house of the Ambassador except during the days of his actual examination, and even then lodged in comfortable rooms in the apartments of the Commissary Fiscal, instead of in the ordinary prison. Of what took place during the examination we are not completely informed. That the prisoner was threatened with the torture is certain; whether it was actually inflicted is still a moot point. Von Gebler very confidently maintains that it was not, and his reasoning at least proves that, if employed at all, it must have been but slightly.

The closing portion of the narrative presents a dismal picture of years lingered out amid severe physical suffering under the stony-hearted supervision, constant petty interference, and reiterated threats of the Holy Office. And when at last the old man dies, blind and helpless, but surrounded with a glory destined to outlive that of popes and cardinals, the Inquisition is seen nervously bustling about to prevent any memorial being erected to the great astronomer, "lest the good be scandalised," or if that could not be achieved, at least to secure that neither in the inscription nor in the oration pronounced at the grave, "words should occur injurious to the reputation of this tribunal."

"The feeble Duke of Tuscany did not venture to disregard in the smallest degree these unamiable Papal wishes. Even the last directions of Galileo, that he should be laid in the tomb of his ancestors in the church of Santa Croce at Florence, were not respected. The insignificant side chapel of that church, called the *capella del novisiato*, received the mortal remains of the great departed. His body was there buried quietly and without public ceremonial in accordance with the will of Urban VIII. No memorial, no inscription marked his last resting-place. But, do what Rome would to wipe out the memory of the famous philosopher, she failed in her attempt to bury in the same grave with his lifeless corpse, the immortal name of Galileo Galilei."

Herr von Gebler has performed his task with meritorious zeal and conscientious labour. He is scrupulously accurate in his use of authorities, and shows a fixed determination—no small merit in a biographer of Galileo—not to exchange the standing-ground of history for the quicksands of ecclesiastical controversy. His narrative is clear and readable, though not free from a tendency to diffuseness and verbal redundancy which are more sharply criticised in England than in Germany. On one point only does he appear to me open to any serious censure,

viz., in the amount of recognition which he has assigned to the principal pioneer in the department of history on which he writes, I mean, of course, Dr. Wohlwill. Without wishing to imply that von Gebler has intentionally minimized the credit he has given to Wohlwill, I certainly think that a person acquainted with the latter's pamphlet only by the former's references, would form an inadequate conception of the extent to which its few and unassuming pages have supplied both materials and suggestions since incorporated and turned to account in the present work.

SEDLEY TAYLOR

MARGARY'S JOURNALS AND LETTERS

The Journey of Augustus Raymond Margary from Shanghae to Bhamô, and back to Manwyne. From his Journals and Letters. With a brief Biographical Preface, and concluding Chapter, by Sir Rutherford Alcock, K.C.B. Portrait and Map. (London: Macmillan and Co., 1876.)

THE publication of these journals and letters can only serve to confirm and deepen the general regret felt at the untimely fate of Mr. Margary. After looking at the manly, genial, and determined face which Jeens has so faithfully reproduced, and reading the hurried but able and invariably interesting notes which have been preserved of the now famous journey, one burns with vexation that through some possibly preventible misunderstanding or ignorant blunder, so promising and noble a youth should have been sacrificed, just when he had shown of how great things he was capable. We need not here enter into details with which, doubtless, all our readers are familiar through the daily press, and to which we have already referred in connection with Dr. Anderson's recent work (vol. xiii., p. 422), to which the present publication is the fitting complement.

The Indian Government had determined to make another attempt—Sladen's in 1868 was a failure—to open up a trade route between Burmah and China. A party was to leave Bhamô in January, 1875, cross the frontier, and make its way to Shanghae. It was thought advisable that some one should traverse the route in an opposite direction, so as to meet this party on the frontier; Mr. Margary, who had been for some years in our Consular Chinese Service as interpreter, was selected for the critical but honourable duty, and in accordance with instructions set out from Shanghae in August, 1874. The energetic youth—he was twenty-eight years of age—eager to be of use in the world, and naturally eager for distinction, rejoiced to have such a splendid opportunity, dangerous though he knew the task to be, and with speed and secrecy made his preparations, and set out furnished with a pass from the Chinese Government. He had a journey before him of not far short of 2,000 miles, right through the heart of the Chinese Empire, a large portion of the distance over ground not previously traversed by any European. About one half of the distance was in steamer and by boat up the Yang-tse-Kiang, and its tributary, the Yuan. At Chen-Yuan-Fu, in the Kwei Chou province, he was furnished with carriers and baggage animals, and thus safely made his way to his destination, Bhamô, in Burmah, a short distance on the other side of the Chinese frontier. Probably no one ever made a journey of such length through any part of China and met with fewer obstructions. It was not the pass he was provided with that alone did it, for in one or two instances the officials of towns could annoy him in spite of it. It was his humanity, his toleration, his geniality and sense of humour and disposition to see the best side of everything and everybody; it was these qualities combined with his perfect acquaintance with the language and knowledge of and respect for Chinese customs, along with a determination to make his mission a success, that carried him safely and happily through circumstances in which ninety-nine others would have come to grief.

During a great part of his journey, Mr. Margary was almost prostrated by illnesses of various kinds; yet those are mistaken who think that the book before us contains merely a few meagre scraps thrown together to make up a volume. In spite of illnesses and of the fact that as in duty bound he made all haste to get to the end of his journey, Mr. Margary contrived, by observation and intercourse, to obtain a substantial amount of really valuable information about the country and the people through which he passed. He had of course no time for minute exploration, though a fair acquaintance with geology and botany qualified him for profitable work of this kind; but his journals and letters contain many important notes on the physical geography and resources of the extensive tract through which his journey lay. He kept eyes and ears open, and his notes show that in this part of China there is plenty of scope for mining and commercial enterprise, and a fruitful field awaiting the scientific explorer. Many important observations will also be found in these remains concerning the people of the various districts and their ethnological relations. Especially do the notes of his intercourse with officials, and non-officials as well, serve to shed a light on Chinese character that we are sure will be new to many. Mr. Margary set himself from the first to understand the Chinese, a task of the greatest difficulty, and came to the conclusion that the common notions on this curious people are far from correct.

The brief biographical sketch and a few early letters enable one to trace the growth and training of the unfortunate youth from his school-days. He was evidently made of excellent stuff to begin with, and took the best possible advantage of his educational opportunities. When only about twenty he was appointed as interpreter to China. Here he speedily acquired a mastery of the language, and did duty at various places before his last settlement at Shanghae. While on the island of Formosa he supplemented his defective scientific education by, as we have said, the acquisition of a knowledge of botany and zoology. On several occasions, moreover, before his final feat, he showed his readiness of resource, bravery, determination, and skill in dealing with men. And yet, through some yet unexplained blunder, this splendid young fellow, so well adapted for long service to his country and to science, was obscurely and brutally murdered in a petty Chinese village. The mission under Col. Browne had proceeded on its way some little distance beyond the Burman frontier, when Margary volunteered to go forward with one or two attendants to remove some seemingly small obstruction at Manwyne. No more was

seen of him alive by his party; his murder at Manwyne was evidently part of a scheme to attack and murder the whole party, who of course returned frustrated in their object.

It is not for us to enter into any discussion as to who are the real authors of the treacherous affair, so far as data permit, Sir Rutherford Alcock discusses the whole question, as well as shows the value of Margary and of his journey, in an Appendix. Whoever was to blame, Margary himself was blameless. it is difficult to regard his death as anything but an unrelieved loss. we trust her Majesty's Consular Service contains many like him.

OUR BOOK SHELF

Through Bosnia and the Herzegovina on Foot during the Insurrection, August and September, 1875. By Arthur J. Evans, B.A., F.S.A. With a Map and 58 Illustrations. (London: Longmans and Co., 1876.)

THIS is an opportune publication, and we recommend it to our readers as one that will give them a good and lively idea of the countries referred to and their various peoples—of much interest at present in connection with the Servian rising. Mr. Evans entered Bosnia at Brod on the Save, went leisurely south, with various divergences, through the country, reaching the sea near the mouth of the Narenta and coasting along to Ragusa. Mr. Evans mixed freely with all classes of the people wherever he went, is well acquainted with Bosnian, and indeed with general European history, is a discriminating ethnologist, and has a good knowledge of botany. He studied the features and habits of the people closely as he sojourned among them, and gives many notes that might be found of value to those who take interest both in Aryan and Turanian ethnology. The people are evidently capable of good things if they had the chance and were free from oppression; but Mr. Evans's observation confirms all that has been said as to the impossibility of the Turk ever treating a Christian subject with justice or even humanity, unless compelled. The book contains a map and many attractive illustrations, is interestingly written, and will give English readers a fair idea of a country that is almost as little known to the generality as the heart of Africa.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Firths, Dales, and Lakes, Valleys and Cañons

IN NATURE, vol. xiii. p. 481, you honoured me by printing a notice of some writings on glacial subjects, and since then many pamphlets have been sent to me. I would gladly show that I have studied them. Though I do not believe in a "glacial period," I have convinced myself that local glacial climates, like the existing climate of Greenland and the "Arctic current" have prevailed in different regions at different times, and that marks of these "local glacial periods" include "valleys" of certain forms, with "firths" and "lake basins." Glaciation occupied the attention of the Geological Society at their last meeting, when Prof. Ramsay read an abstract of a paper, in which a foreign writer compared Greenland and Norway. So far as I understand that writer's views as to glacial action in general, I agree with him. Many writers hold opposite opinions as to "the usual evidence of powerful ice erosion," and "the alleged power of a glacier to excavate a depression in the earth's surface" (Judd), as to "abrasion," and "the inability of glaciers to excavate except under peculiarly favourable circumstances" (Bonney). Truth is learned by observation and by perseverance. A drop hollows a stone, not by force, but by frequent falling, and that truth has become proverbial. A stream of water by flowing, and by rolling stones, makes a watercourse, and that truth is proved by every shower and in every gutter. By perseverance flowing water makes a deep watercourse. According to the latest official report of Dr. Hayden (June 4, 1876), streams which began to flow about the sources of the Mississippi, when the Rocky Mountains were raised, have gone on flowing ever since in the same channels, and some have worn cañons "from half a mile to a mile deep," not by force, but by frequent flowing. A glacier also flows. It is acknowledged that it wears and grooves rock, but still it is denied that a wide deep stream of flowing ice can make a wide deep furrow. It is said that ice "abrades," but does not "erode," that it cannot "excavate," unless under favourable circumstances. It is maintained that flowing ice cannot hollow out a basin, though flowing water does it on a small scale wherever it flows. Much is done by perseverance. As a drop hollows a stone, and water a watercourse, so ice makes an ice channel slowly, and much repetition by glacialists may in time convince sceptics of that truth. Icebergs are the ends of glaciers pushed out into the sea, and there launched. Some of them are 3,000 feet thick. They prove their size by grounding in soundings off Newfoundland, and Labrador, and Greenland, and by their rate of flotation when they float with 300 feet above water, as "flat topped islands of ice" in southern seas. A "glacier" cannot easily be measured on shore, but these vagrant fragments roughly measure parent glaciers. A pressure of 3,000, or of 1,000, or of 500 feet of ice upon sand or stone moving in an ice-channel is great abrading force. At the base of every ice fall, or ice rapid, the plunging ice river must tend to "excavate," because falls and rapids of water excavate pools of various sizes proportioned to their power. The area of Greenland nearly equals that of India, and that area, so far as it is known, is covered with thick ice which is slowly moving seawards. The coasts are furrowed by deep hollows, of which most contain flowing glaciers, of which many enter the sea, and launch "islands of ice." Some "bergs" now float to the lowest latitude reached by northern drift stones on shore in Europe and in America. I say nothing here about marine glaciation. The Greenland glaciers are flowing from an area where water generally falls frozen; they flow as rivers now flow from India, and all of them are slowly wearing their channels at some rate, and working up stream like Niagara Falls. There is no measure for the time during which these powerful ice rivers of Greenland have been slowly hollowing stone by frequent flowing, unless it be the work of erosion done. It is denied that the work was done by the glaciers. Yet no rivers flow where ice fills the dales, and these Greenland dales have been "eroded," and bear "the usual evidence of powerful ice erosion," according to photography and descriptions. According to the clearest marks the whole Scandinavian peninsula, and the whole of Finland have at some time been covered by ice on the scale of Greenland ice. Sermitsialik glacier, photographed by Mr. Bradford before 1870, is near Cape Desolation in Greenland, opposite to Shetland, Bergen, Christiania, St. Petersburg, &c. It is from three and a half to four miles wide where it enters the sea, and there it is about 800 feet thick. It extends inland as far as the eye can reach, and probably comes from the watershed of Greenland. Taking the ice to weigh only 55 lbs. per foot cube, the pressure above the sea level on the ice channel is about 44,000 lbs. on the foot square. Between ice and rock are huge stones, grit, and mud, and the rock is rounded where it is visible at the edge of the glacier, near the sea-level. The slopes between the lakes of Finland, and the gulf near Viborg, at the side of the Saimen canal, and elsewhere, are polished, striated, and rounded. I took rubbings in September, 1865, and recognised the work of ice on the scale of Greenland ice. In Norway the old marks are plain on the sides of firths and dales, and some lead back to glaciers, which still flow from large areas upon the watershed, which still are covered by considerable sheets of ice. In Greenland this engine is seen at work, in Scandinavia the work of the engine is better seen. That work is, first a rounded worn plateau about the watershed called the "fjeld," second, a series of slopes much glaciated, and third, below these slopes, long grooves hollowed out of the solid, called "dales." In these dales rivers now flow to lakes and to firths. Of these rivers some have worn deep watercourses, and cañons proportioned to their size and age. At the bottom of the dales are hollows which are called lakes, and firths when they hold fresh or salt water, in the rivers are smaller

pools, which become ponds in dry weather. This northern country opposite to Greenland has been "carved" in this fashion by ice on the large scale, and afterwards by water-streams, and by the frequent falling of rain drops. It has also risen from the sea. The ice-cover has been taken off Scandinavia and Finland, and there it is possible to test theories about the work which an ice-cover is now doing on the present chief gathering grounds of snow throughout the world. But that Scandinavian work is the same kind of work which is found with small glacial marks elsewhere. Hollows have rounded sections ⌣, or when deep they are like U. Hills between hollows commonly are hog-backs ⌢, and generally the land is rounded, except where peaks rise, and cliffs have broken. But this kind of rounded sculpture exists only in some regions of the world, and it marks the site of local glacial periods, as I believe. Elsewhere the section of valleys is angular like V, or in cañon countries like Y. These angular grooves are known to be the work of streams, because every stream of water carves on the same plan. Rounded hills and dales are at first sight evidence of powerful ice erosion, but some kinds of rock weather in bosses. If it be admitted that a drop wears a stone, that a stream makes a deep cañon in a long time, and that a glacier "abrades" or makes any mark at all, it seems to follow that an ice-engine as large as India or Scandinavia has in fact done the large work which it might be expected to do by perseverance in working, as it is known to work, wherever snow now gathers in large masses. Given the hardly perceptible wearing of water and time, a cañon a mile deep and many hundreds of miles long has resulted from the flowing of a stream. Given glacial "abrasion" and time enough, than valleys of rounded section, and firths and lake-basins of a particular kind probably resulted from the flowing of ice.

There are plenty of hollows in the earth's surface which are not the result of erosion but of other causes with which I am not now concerned. Where a stream flows from source to mouth on a gradual slope, there has been no great disturbance of level since the stream began to work. Where ice fills the dales there are no cañons. Where ice has filled dales and has left fresh marks, cañons are short and small. In mountain regions where ice-marks are rare or absent, cañons are of great depth and length, apparently because their streams have flowed in the same channels ever since the mountains were raised. But where cañons are marked features, these lakes, firths, and dales of rounded section are very rare, or do not exist. It seems therefore that hollows which have, in fact, been carved out of the earth's surface may be known for water-work, or for ice-work by their shape, and that firths, dales, and lakes may mark the sites of local glacial periods; and cañons the sites of climates that have not been glacial since the streams began to flow. Perseverance may accomplish great results insensibly like ice in dales, water in water-courses, and drops on stone.

Let me counsel those who wish to study the works of ice on a large scale to abandon the retiring glaciers of Switzerland and study Nature in Norway. This is the best season for travelling there. J. C.

June 23

The Loan Scientific Collection at South Kensington

As a science teacher, privileged to attend the special demonstrations upon the extraordinary assemblage of apparatus now filling the galleries of the exhibition buildings, a list of some of which appeared in last week's NATURE, would you allow me to call attention to the provision of the department by which the general public may be admitted, if room, at a nominal charge.

Within the past few days my note-book shows that the original instruments of Sir Isaac Newton, Faraday, Fizeau, Wheatstone, Watt, Savery, Black, Cavendish, Guericke, and others employed in their classic researches, have been shown and explained (and used, so far as experimentalists would presume to touch such now almost venerated relics).

The spacious and well-appointed lecture-theatre has not been always crowded; but I have the impression that if the above regulation were widely understood there would be such a gathering, not of the merely curious, who would attend as at an entertainment in natural magic, but of those deeply interested in the topics discussed, as would prove too large for the accommodation at present provided; and, whilst scientific enrichment of the public would be more largely secured, a compliment would at the same time be paid to the directors for their great efforts to promote the success of this important undertaking.

The School of Science, July 6 WILLIAM GEE

Evolution of Oxygen by "Vallisneria Spiralis"

HAVE any of your readers noticed the rapid evolution of oxygen by a blade of *Vallisneria spiralis*? If a blade is cut or broken and held under water, the bubbles of gas are rapidly noticed issuing from the broken end, and by a simple arrangement of placing the broken blade or several blades into a test tube filled with water the water is displaced and the gas collected. After forty-eight hours the pores of the broken end of the blade close up and a fresh fracture is necessary to restore the evolution of gas, which also ceases at night only to recommence when the sunlight reappears. I have collected about a cubic inch of gas in eight hours from one blade of the plant. A confirmation of my experiment would please me.

Stroud, July 3 WALTER J. STANTON

Stamens of Kalmia

IF the beautiful spring trap formed by the stamens of the Kalmia, by which insect fertilisation is secured, has not yet been noticed, I may perhaps be allowed to call attention to it.

Cahirmoyle, Ardagh, Co. Limerick C. G. O'BRIEN

Optical Phenomenon

FOR more than half an hour after sunset this evening there was a broad band of light rising vertically through a clear sky immediately above where the sun had set. It moved as the sun moved northward below the horizon, retaining its vertical position. It must have been formed at a very great height in the atmosphere, for it outlasted all the other sunset tints, which were very beautiful. It would be interesting to know whether this was seen from many places far apart. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, June 27

The Cuckoo

WITH regard to the letter of Mr. Adair, in last week's NATURE, p. 210, on the cuckoo, I have only to observe that if it does not sing in Somersetshire after Midsummer it does *here*, in Middlesex; I heard it, to my astonishment, early in the morning of the 6th inst., in the woods and hills to the north. I never recollect its note so late, not after the 3rd.

Harrow, July 10 HENRY ST. JOHN JOYNER

OUR ASTRONOMICAL COLUMN

SHORT'S OBSERVATION OF A SUPPOSED SATELLITE OF VENUS.—This observation which, as it appears in the *Philosophical Transactions*, vol. xli. (NATURE, vol. xiv., p. 194), is mystified by a typographical error, is also found in "Histoire de l'Academie des Sciences, 1741," p. 125, where the micrometrically-measured distance of the suspicious object from Venus is given in what seems to be a more correct form, and as it was used by Lambert in his calculations. After referring to the observations of the elder Cassini in 1672 and 1686, the writer—probably Cassini II., author of "Elemens d'Astronomie"—states that Mr. Short had again seen the satellite, real or apparent, in the preceding year (1740), under similar circumstances, and with the same phase as Cassini had described; he had been informed of this in January, 1741, by M. Coste, "auteur de la Traduction du livre de l'Entendement Humain de Locke, et de plusieurs autres ouvrages;' and having communicated the observation to the Academy of Sciences, had been charged by that body to inquire more particularly concerning it, and report the result. But as Short had not seen the satellite again up to June, 1741, nothing further was ascertained than had been notified in the letter addressed to M. Coste, which was from "Mr. Turner, written from London, June 8."

Short's observation was "made in London, November 3, 1740, in the morning, with a reflecting telescope of 16½ English inches, and which magnified the diameter of the object from fifty to sixty times. He perceived at first what appeared to be a small star very near to Venus, upon which, having applied to his telescope a stronger eyepiece and a micrometer, he found the distance of the

small star from Venus, 10 minutes 20 seconds. Venus then appeared very distinctly, and the sky being very clear, he took eyepieces three or four times more powerful, and saw, with an agreeable surprise, that the small star showed a phase, and the same phase as Venus; its diameter was rather less than a third of that of Venus, its light not so vivid but well defined; the great circle which passed through the centres of Venus and of the satellite, which it would be difficult to designate otherwise, made an angle of about 18 to 20 degrees with the equator, the satellite being a little towards the north, and preceding Venus in right ascension. Mr. Short examined it at different times and with different telescopes during the space of an hour, until the light of day or of the twilight obliterated it entirely."

It will be seen that Short's observation, divested of the typographical error in the *Phil. Trans.*, by which it was confused, is intelligible enough, and it may not be without interest if we examine the circumstances under which it must have been made.

Taking the place of Venus with sufficient precision for the purpose in view from the tables of Le Verrier, we have the following figures:—It may be premised that the date given in NATURE last week from the *Phil. Trans.* is the morning of October 23, but it is to be remembered that the Gregorian style had not then been introduced in this country; in the present mode of reckoning, it becomes the morning of November 3, as stated in the "Histoire de l'Académie."

G M T	Venus, App R A	App. N P D.	Dist of Venus from the Earth
1740, Nov. 2, at $18^h\ 30^m$	175° 21′ 11″	87° 12′ 21″	0·7007.

Hourly motion in R.A. + 2′ 28″; in N.P.D + 0′ 49″.

The apparent diameter of Venus (Le Verrier) was 23″·7, and her heliocentric longitude being 86° 11′, and her geocentric longitude 174° 38′; the breadth of the illuminated portion of her disc was 0·514; elongation, W. 46½°.

Short says the daylight put a stop to his observations "about a quarter of an hour after eight," which we may assume to imply apparent time, and as the correction from apparent to mean time was then $16^m \cdot 1$ subtractive, his observation may be supposed to have terminated at 8 A.M., and as he had viewed the object during the space of an hour, we find Venus must have been at an altitude of 36° when he first perceived it, and further, it should be noted, the sun rose at $7^h\ 0^m$, so that Short's observations must have been made entirely in daylight, with the planet particularly well situated.

The suspected satellite was 18°-20° north-preceding Venus, which implies a mean angle of position of 289°, and as the distance was 10′ 20″, we have for the difference of right ascension, $39^s \cdot 1$, and for the difference of N.P.D., 3′ 22″. Supposing these differences to apply to $7^h\ 30^m$ A.M., the position of the object would be R.A. $11^h\ 40^m\ 50^s \cdot 6$, N.P.D. 87° 9′ 23″; whence, bringing forward to the epoch of the *Durchmusterung*, its R.A. is $11^h\ 46^m\ 46^s$, N.P.D. 87° 47′·5 for 1855·0.

Unless we had been able to correct the misprint in the *Phil. Trans.* by the French account of the observation, it might, perhaps, have been inferred that the distance was intended to be 1° 2′ or 1° 12′, and in this case the 3·4 magnitude star β Virginis would have fallen very nearly upon Short's position; at 7 A.M. this star preceded Venus 1° 5′, and was N. 26′.

It will be found that our examination of Short's observation does not tend to explain it. Though Lalande thought when conversing with him on the subject in 1763, that he doubted his having observed a satellite of Venus, he appears to have been sufficiently impressed with his observation to have had the appearance engraved, and to have "carried it with him as a seal."

The observation of Andreas Mayer at Greifswald, mentioned in NATURE last week in the notice of Schorr's "Der Venusmond," was communicated to Lambert after the appearance of his memoir "Essai d'une théorie du satellite de Vénus," in the Berlin Memoirs, 1773, of which an abstract is found in the *Astronomisches Jahrbuch*, 1777. It is printed at p. 186 of the *Jahrbuch* for 1778, where also appear the two letters from Abraham Scheuten to Lambert, referring to his observations of what he believed to be a satellite of Venus, *after* the planet had left the sun's disc in the transit of 1761, June 6, which at noon at Crefeld was near the centre of the disc and at 3 P.M., near the limb. Lambert follows with a particular examination of Scheuten's observation in connection with the observations of Montaigne at Limoges in May preceding.

γ ARGUS.—Gilliss, in the notes to the 1850 "Catalogue of Double Stars observed at Santiago," remarks of this object: "The cluster deserves special attention for its evident changes since Herschel's observations." From a comparison of the observations it is not obvious to what changes reference is here made. Perhaps some reader of NATURE who can favourably command this star's position will describe the actual configuration, &c., of the principal star and *vicinæ*.

Mr. S. M. Drach writes with reference to views of binary stars from Venus and Mars: "Has it ever been noticed by cosmographists that an observer at these planets must see our moon at a maximum elongation-angle from our earth, ranging from Venus from $5\frac{1}{11}$ to $31\frac{1}{7}$ minutes of degree, and from Mars from $3\frac{1}{3}$ to $16\frac{5}{6}$ minutes of degree, whence follows that our *present century's* certitude of Binary Stellar Systems is a PRIMITIVE feature of naked-eye astronomy to the Venus or Mars observers. This elongation diminishes to zero in about seven days of either planet, since their rotation periods nearly equal the earth's."

THE NORWEGIAN-ATLANTIC EXPEDITION

THIS Expedition left Bergen June 1 for the Sognefiord, where the first week was spent in preparatory work—sounding, dredging, and trawling in 600 fathoms. The temperature at the bottom was found exactly the same as in former years, 43°·7 F. The fauna was a mixture of Atlantic and Arctic. There were found several specimens of *Brisinga coronata* (Sars), *Munida tenuimana*, one large *Actinia* and a sponge, *Tisiphonia agariciformis*, and, among other mollusca, *Axinus eumyarius* (Sars), *Kelliella abyssicola* (Sars), *Malletia obtusa*, and *Taranis Mörchi*. The second week was spent at Huso, a small island at the mouth of the Sognefiord, where magnetical base-observations were made on shore and on board, ship swung for deviation, &c.

June 20 the Expedition left this place, and steered along the deep channel surrounding Southern Norway from the Skagerrack up to Cape Stadt. The first soundings and dredgings showed a very flat bottom at a depth of about 200 fathoms, and with a fauna mainly Atlantic. About 150 miles N.W. of Cape Stadt the temperature began to fall, the depth remaining unchanged. At the next sounding the depth increased and the bottom temperature was still falling, until at last the Miller-Casella thermometer showed 32° at 300 fathoms, and 30° at the bottom in 400 fathoms. This is exactly like what the *Porcupine* found in the *Lightning* Channel. Off Stadt the fauna was Arctic and Glacial. Among the specimens brought up was a gigantic *Umbellularia*, 5 feet high, a *Nymphon*, 10 inches between the ends of the feet, a new large *Archaster*, and many other characteristic forms. No less than eight forms of Hydroids were also found at this depth, three different species of Arctic *Fusus*, and several specimens of *Yoldia intermedia*, &c.

The Expedition ran into Christiansund June 23, and was to leave that port in a few days for the Faroes and Iceland.

THE KINEMATICS OF MACHINERY[1]

II.

AFTER the discussion of lower pairs of elements, higher pairs are considered, such, for instance, as that of the duangle and triangle, the motions of which with respect to each other are thoroughly described. One of the most useful sections of the book, and which we strongly recommend to the attention of engineers and machinists, is that on the General Determination of Profiles of Elements for a given Motion (p. 146). To the practical mechanic who has read the discussion on the different pairs of elements, it must appear that there are some motions taking place in machines in the required manner that are not constrained completely by the resistance of the parts of the machine, such, for example, as the motion of the bed-plate of a planing machine in the V guides, and it is obvious that this motion would not be constrained to take place in the required manner if the machine were turned upside down. The constraint only in certain positions of the pair of elements is called *force closure*, and the pair is called an incomplete pair of elements, the determination of the motion in the required manner being effected only with the assistance of the weight of one element, which must be greater than any disturbing force tending to cause motion in the direction opposite to that in which its weight acts. As examples of force-closed pairs are mentioned the plummer block of a water-wheel, which, owing to the weight of the wheel, constrains the motion without the complete closure of the pair by the addition of the cap, also railway wheels with the metals on which they roll.

We pass now to the History of Machine Development. "At the commencement of a study of machine development it is first of all necessary to know distinctly what it is that makes a machine complete or incomplete. It is only possible to judge of the completeness of a machine from the excellence of the work produced by it, if we are able to estimate separately what part of the result is due to the skill of the workman. Certain Indian fabrics, for instance, are of extraordinary excellence and delicacy, although they have been made in most defective looms; throughout the whole manufacture of these it is the weaver's dexterity that plays the most important part. In no machines can we absolutely do away with human action, if it be for no further purpose than to start and stop the process. It appears, therefore, that the most complete machine is the one fulfilling best its own work, and having for this share the greatest proportion of the whole task." The great use of tracing the history of the development of machines is, that the more clear the path along which real advance has come to pass can be laid down, the more clearly we are enabled to see the direction that must be taken by succeeding advances. Probably the earliest machine known is the fire-drill, used in very early days of the development of the human race for producing fire by its rapid rotation between the hands, being at the same time held in firm contact with another flat piece of wood. The improvements on this appear to have been pointing the fire-drill at the other end, enabling the vertical pressure to be supplied by an assistant by means of a flat piece pressed on the top of the drill,

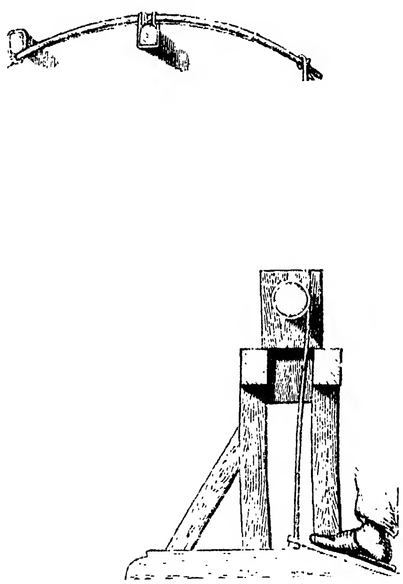


FIG. 5.

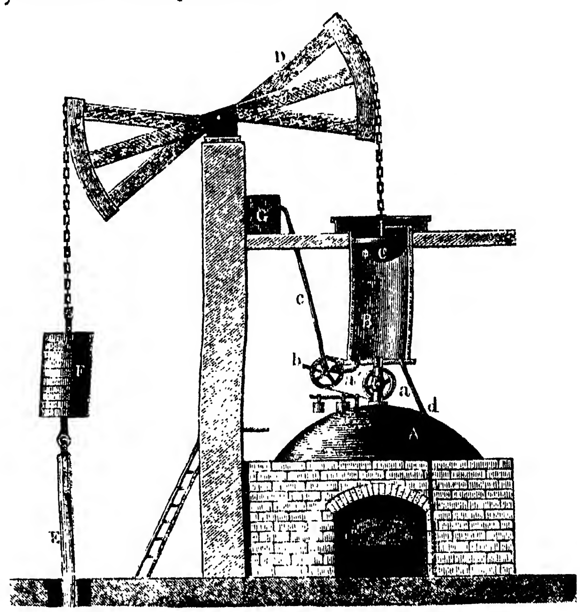


FIG. 6.

and communicating the rotation to the drill by means of a cord wrapped once or twice round it. The applications of this tool seem to have been numerous, as with it hard woods, bone, horn, and even hard stones, appear to have been drilled, no doubt with the assistance of a supply of sand and water. From the fire-drill, probably after a very long interval, sprang the potter's wheel, and the earliest forms of turning-lathe turned in a similar manner; the principle is preserved to the present day in the bow-drill used for light metal-work. The origin of the screw and nut is lost in obscurity, but this pair of elements was certainly known to the Greeks and Romans; Prof. Reuleaux's suggestion of its origin, tracing it to the fire-drill, is very ingenious, even if it is not the right one; that with long-continued use of the drill, the cord may have worn spiral groves on the spindle, forming a screw-thread while the cord itself formed the nut. "The forms of the word screw in the Germanic languages greatly strengthen my suggestion. We cannot take into account the fact that in English and the Romance languages the characteristic portion of the screw is called 'thread' (*filo, filet*),

[1] "The Kinematics of Machinery: Outlines of a Theory of Machines." By F. Reuleaux, Director of and Professor in the Königlichen Gewerbe-Akademie in Berlin, Member of the Königl. technischen Deputation für Gewerbe. Translated and edited by Alex. B. W. Kennedy, C.E., Professor of Civil and Mechanical Engineering in University College, London. (London: Macmillan and Co., 1876.) Continued from p. 214.

for this name may have been subsequently given to it." Again, "The bow of the archer is a machinal organ in which energy is stored; the sensible force of the muscles is made latent in it, and it is this latent energy stored in the elastic bow which actually propels the arrow. In the ballista and catapult this principle receives still more extended application, for in them kinematic means are employed to store the energy of many men, so as to employ it concentrated with correspondingly increased effect. Later on the same principle extends itself to primary forces, and it is to-day more used than ever, from the tiny watch-work or the spring of a gun-lock, through innumerable mechanisms, up to the Armstrong accumulator or the air-vessels of the Mont Cénis borers." But it is from the kinematic point of view that the progress of the development of the machine is most accurately measured. What is the fundamental characteristic of the improvement that has been effected in the various stages of advance in the development of a machine? Prof. Reuleaux answers: "The line of progress is indicated in the manner of using force-closure or more particularly in the substitution of pair closure and the closure of the kinematic chains obtained by it for force-closure." In the fire-drill, which is an early form of turning-pair, we have not only force-closure by the action of the hands in the longitudinal direction, previous to the introduction of the bearing-piece on the top, but also force-closure in the transverse direction by the hands. The invention of the string for turning the drill, itself a great advance, introduces another kinetic pair of elements, but still the string is constrained to keep in contact with the stick by the force-closure of the tension produced by the hands. In the earliest form of lathe with double head-stocks, the force-closure of the double element is changed to pair-closure, marking a great advance in the development of the machine, and the string is worked in a more definite manner by one end being fastened to a bow or spring-beam, whilst the other is worked by the foot (Fig. 5).

"Thus simplicity or fewness of parts does not itself constitute excellence as a machine, but increased exactness in the motions obtained, with diminished demands on the intelligence of any source of energy."

In more recent machinery, such as Newcomen's engine (Fig. 6), we see the connection of the beam D and the pump-rod E, affected by the force-closure of the weight F acting on the chain, the connection of the piston C, and the beam D, affected by force-closure also, by the same weight, whilst the valve-gear was worked by hand.

By the invention of his nearly perfect parallel motion, Watt introduced kinematic pair and chain-closure into the steam-engine, as well as by the introduction of automatic valve-gear. Space will not permit us to give an account of the systems of kinematic notation proposed by Prof. Reuleaux, but it certainly is one of the most important chapters in the book, and will well repay a careful study, although some little time and trouble is evidently required to get the meaning of the various symbols impressed on the memory. When this has been done we have no doubt that it will amply compensate the learner for his pains, by the much more ready comprehension he will obtain of complex mechanisms. We can only say, in the words of our author, "The reader need not fear that any continual alteration of his accustomed ideas will be demanded from him in making himself familiar with the system of contractions. For a scientific symbolic notation is in essence nothing else than a systematised method of contraction—it is not a hieroglyphic system mysterious to the uninitiated." Under the head of analysis of chamber-crank chains, the various disc-engines, rotatory engines and blowers, of which such a large and varied assortment has been from time to time invented, are described and figured, and our author states at the end of the long list so formed that the whole of the forms that have appeared are probably not exhausted, and that "a comparison of the machines described shows, indeed, that there are many easily constructed inversions of existing mechanisms which have not yet been proposed, and many analogies to existing forms which have not been tried; so we may look forward still to the production of whole series of chamber-crank trains by the never resting empirics. In Chapter xi. we come to the machine considered as a combination of constructive elements and the complete enumeration of them, and their systematic classification deserves particular attention. As an example of this classification we may give the double-acting ratchet train (Fig. 7) and the double-

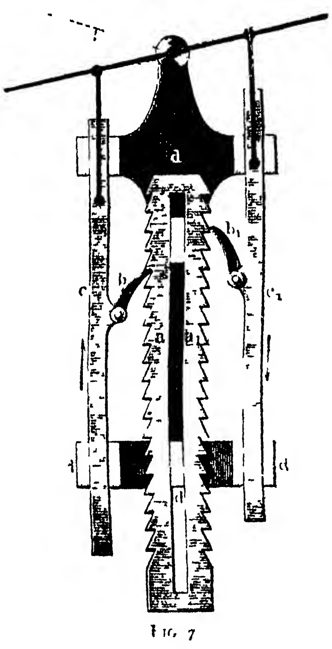


FIG. 7

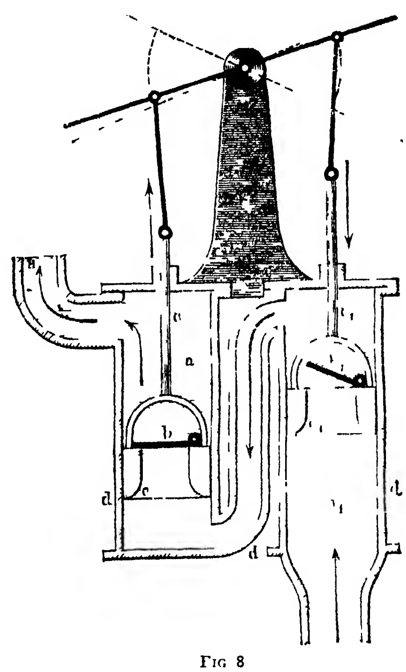


FIG. 8

acting pump (Fig. 8); these are classed together, and a closer examination of the function and elements of each will immediately show the correctness of so doing. The two bars *c* and *c* in the ratchet train correspond with the two pump rods and buckets. The pump barrels *d d* correspond with the guide frames *d d* of the ratchet train, the valves *b* and *b* correspond with the pawls *b* and *b*, while the water in the two barrels is the exact equivalent of the ratchet *a a*. As the bar *c* descends the pawl *b* would pass over a certain number of teeth of the ratchet equal to the number in the length of stroke of *c*, if the bar *c* was disconnected with the lever but as it is, during the descent of *c*, through a certain distance the ratchet is lifted an equal distance by the other pawl *b*; thus we see that each pawl passes over twice as many teeth of the ratchet as correspond to the length of its stroke. This has an exact parallel in the double-acting pump, for there also each bucket in its down stroke moves through a length of water equal to double the length of its stroke. The following is the outline of Prof. Reuleaux' Classification of Constructive Elements :—

Rigid Elements—
- Joints (for forming links) such as rivets, keys, keyed joints.
- Elements in pairs or in links, such as shafts and axles, levers, cranks, &c.

Flectional Elements—
- Tension organs by themselves and used with chain-closure, such as belts, cords.
- Partners of pressure organs such as pistons and plungers, steam cylinders and pump barrels.
- Springs.

Trains—
- Click-gear.
- Brakes.
- Movable couplings and clutches

In conclusion we must say that the cuts illustrating the book, are much superior to those generally to be found in theoretical books on machinery, but they do not, of course, equal the elaborate working drawings to be found in certain books on machine design. In Fig. 169, p. 218, the rope appears to have somewhat lost its way. The translator has done his work most admirably, and great must have been the ingenuity required to manufacture some of the names here presented for the first time to the English reader. In fact we could hardly imagine a book more difficult to translate, on account of the great number of specially-constructed words in it, nor do we remember having read one in which the duties of the translator have been more successfully carried out. The book appears at a particularly suitable time, now that the beautiful and extensive collection of kinematic models by Prof. Reuleaux, designed by him and constructed especially to illustrate his treatment of the theory of mechanism, is to be seen at the Loan Collection of Scientific Instruments at South Kensington.

PERIGENESIS v. PANGENESIS—HAECKEL'S NEW THEORY OF HEREDITY

UNDER the title "Perigenesis der Plastidule oder die Wellenzeugung der Lebenstheilchen," Prof. Haeckel has published quite recently a pamphlet containing an attempt to furnish a mechanical explanation of the elementary phenomena of reproduction which shall be more satisfactory than Mr. Darwin's ingenious and well-known theory of Pangenesis. I shall endeavour to show that Prof. Haeckel's theory is essentially that with which both English and German students of Mr. Herbert Spencer's works have long been familiar; and that it does not furnish a clearer explanation than does Mr. Darwin's Pangenesis, of the special facts of heredity which Mr. Darwin had in view.

Haeckel commences with a very concise statement of what is at present known as to the visible composition of "plastids," those corpuscles of life-stuff called "cells" by Schleiden and Schwann, "elementary organisms" by Brücke, "life-units" by Darwin. Most plastids possess a differentiated central kernel or nucleus, which again possesses one or more nucleoli. The substance of which the body of such a nucleated plastid or *true* cell is mainly composed is generally known by von Mohl's term, "protoplasma." Haeckel proposes to distinguish the substance of the nucleus by the name "coccoplasma." In the simplest form of plastid, the "cytod," which is devoid of nucleus, and is exhibited by those lowly organisms known as Monera, by the young Gregarina (Ed. van Beneden), by the hyphæ of some Fungi, and by the ripe egg of all organisms (if we may judge from the results of the most recent researches), coccoplasm and protoplasm are not differentiated, but exist as one substance, which Haeckel, following Ed. van Beneden, distinguishes as "plasson." Whether these distinctions have a real value or not, is of no moment for the question in hand. It is a widely-accepted doctrine—in fact, the fundamental generalisation on which Biology as a science rests—that the excessively complex chemical compound which forms the substance of plastids or life-units is the ultimate seat of those phenomena or manifestations of energy which distinguish living from lifeless things—to wit, growth by intus-susception, reproduction, adaptation, and continuity or hereditary transmission. Leaving Prof. Haeckel's pamphlet for a time, let us go back thirteen years.

As long ago as July, 1863, Mr. Herbert Spencer, in his "Principles of Biology," pointed out at considerable length (vol. i., p. 181) that the assumption of definite forms, and the power of repair exhibited by organisms, is only to be brought into relation with other facts (that is to say, so far explained) by the assumption that *certain units* composing the living substance or protoplasm of cells possess "polarity" similar to, but not identical with, that of the units which build up crystals. Mr. Spencer is careful to explain that by the term "polarity" we mean simply to avoid a circuitous expression, namely, the still unexplained power which these units have of arranging themselves into a special form. He then points out that the units in question cannot be the molecules of the proximate chemical compounds which we obtain from protoplasm—such as albumen, or fibrin, or gelatin, or even protein. Further he shows that they cannot be the *cells* or morphological units, since such organisms as the Rhizopods are not built up of cells, and since, moreover, "the formation of a cell is to some extent a manifestation of the peculiar power" under consideration. "If then," he continues, "this organic polarity can be possessed neither by the chemical units, nor the morphological units, we must conceive it as possessed by certain intermediate units, which we may term *physiological*. There seems no alternative but to suppose that the chemical units combine into units immensely more complex than themselves, complex as they are; and that in each organism, the physiological units produced by this further compounding of highly compound atoms, have a more or less distinctive character. We must conclude that in each case, some slight difference of composition in these units, leading to some slight difference in their mutual play of forces, produces a difference in the form which the aggregate of them assumes."

Further on Mr. Spencer applies the hypothesis of physiological units to the explanation of the phenomena of heredity, introducing the subject by the following admirable remarks, which appear to me to assign in the most judicious manner, their true value to such hypotheses and to be as strictly applicable to later speculations as to his own. "A positive explanation of heredity is not to be expected in the present state of biology. We

can look for nothing beyond a simplification of the problem, and a reduction of it to the same category with certain other problems which also admit of hypothetical solution only. If an hypothesis which certain other wide-spread phenomena have already thrust upon us, can be shown to render the phenomena of heredity more intelligible than they at present seem, we shall have reason to entertain it. The applicability of any method of interpretation to two different but allied classes of facts is evidence of its truth. The power which organisms display of reproducing lost parts, we saw to be inexplicable except on the assumption that the units of which any organism is built have an innate tendency to arrange themselves into the shape of that organism. We inferred that these units must be the possessors of special polarities, resulting from their special structures; and that by the mutual play of their polarities they are compelled to take the form of the species to which they belong. And the instance of the *Begonia phyllomaniaca* left us no escape from the admission that the ability thus to arrange themselves is latent in the units in every undifferentiated cell. . . . The assumption to which we seem driven by the *ensemble* of the evidence, is that sperm-cells and germ-cells are essentially nothing more than vehicles, in which are contained small groups of the physiological units in a fit state for obeying their proclivity towards the structural arrangement of the species they belong to. . . . If the likeness of offspring to parents is thus determined, it becomes manifest, *a priori*, that besides the transmission of generic and specific peculiarities, there will be a transmission of those individual peculiarities which, arising without assignable causes, are classed as 'spontaneous'. . . .

"That changes of structure caused by changes of action must also be transmitted, however obscurely, from one generation to another, appears to be a deduction from first principles—or if not a specific deduction, still, a general implication. . . . Bringing the question to its ultimate and simplest form, we may say that as on the one hand physiological units will, because of their special polarities, build themselves into an organism of a special structure, so on the other hand, if the structure of this organism is modified by modified function, it will impress some corresponding modification on the structures and polarities of its units. The units and the aggregate must act and re-act on each other. The forces exercised by each unit on the aggregate, and by the aggregate on each unit, must ever tend towards a balance. If nothing prevents, the units will mould the aggregate into a form in equilibrium with their pre-existing polarities. If contrariwise, the aggregate is made by incident actions to take a new form, its forces must tend to re-mould the units into harmony with this new form; and to say that the physiological units are in any degree so re-moulded as to bring their polar forces towards equilibrium with the forces of the modified aggregate, is to say that when separated in the shape of reproductive centres, these units will tend to build themselves up into an aggregate modified in the same direction." (P. 256.)

Thus, then, Mr. Herbert Spencer definitely assumes an order of molecules or units of protoplasm—lower in degree than the visible cell-units or plastids—to the "polar forces" of which and their modification by external agencies and interaction, he ascribes the ultimate responsibility in reproduction, heredity, and adaptation.

I am unable to say whether Mr. Darwin was acquainted with or had considered Mr. Herbert Spencer's hypothesis of physiological units, when in 1868 he published his own provisional hypothesis of Pangenesis. But an examination of the bearings of the two hypotheses shows that the former does not render the latter superfluous, nor is the one inconsistent with the other. Mr. Darwin wished to picture to himself and to enable others to picture to themselves a process which would account for (that is, hold together and explain) not merely the simpler facts of hereditary transmission, but those very curious though abundant cases in which a character is transmitted in a latent form and at last reappears after many generations, such cases being known as "atavism" or "reversion;" and again those cases of latent transmission in which characteristics special to the male are transmitted to the male offspring through the female parent without being manifest in her; and yet again the appearance at a particular period of life of characters inherited and remaining latent in the young organism. According to the hypothesis of pangenesis, "every unit or cell of the body throws off gemmules or undeveloped atoms, which are transmitted to the offspring of both sexes and are multiplied by self-division. They may remain undeveloped during the early years of life or during successive generations; their development into units or cells, like those from which they were derived, depending on their affinity for, and union with, other units or cells previously developed in the due order of growth."

In an essay ("Comparative Longevity," Macmillan, 1870, p. 32) published six years ago, I briefly suggested the possibility of combining Mr. Herbert Spencer's and Mr. Darwin's hypotheses thus: "The persistence of the same material gemmule and the vast increase in the number of gemmules, and consequently of material bulk,[1] make a *material* theory difficult. Modified force-centres, becoming further modified in each generation, such as Mr. Spencer's physiological units, might be made to fit in with Mr. Darwin's hypothesis in other respects." In fact in place of the theory of emission from the constituent cells of an organism of material gemmules which circulate through the system and affect every living cell, and accumulate in sperm-cells and germ-cells, we may substitute the theory of emission of force, the two theories standing to one another in the same relation as the emission and undulatory theories of light.

It may, however, be very fairly questioned whether our conceptions of the vibrations of complex molecules, or in other words their force-affections, are sufficiently advanced to render it desirable to substitute the vaguer though possibly truer undulatory theory of heredity for the more manageable molecular theory (Pangenesis). How are we to conceive of the propagation of such states of force-affection or vibration (as they are vaguely termed) through the organism from unit to unit? In what manner, again, are we to express the dormancy of the pangenetic gemmules in terms of molecular vibration? It is true that molecular physics furnishes us with some analogies in the matter of the propagation of particular states of force-affection from molecule to molecule, as, for example, in the various modes of decomposition exhibited by gun-cotton, in contact actions and the like; but it will require a very extended analysis of both the phenomena of heredity and of molecular phenomena similar to those just cited, to enable us to supersede the admittedly provisional hypothesis of Pangenesis by a hypothesis of vibrations. And it is necessary here to remark that in the fundamental conception of Pangenesis, namely, the detachment from the living cells of the organism of gemmules which then circulate in the organism, there is nothing contrary to analogy, but rather in accordance with it. It is quite certain that in some infective diseases the contagion is spread by specific material particles. This seems to be established, although it is far from settled as to whether these particles are parasitic organisms or portions of the diseased organism itself. Mr. Darwin's pangenetic gemmules may, even if not accumulated and transmitted from generation to generation, be called upon to explain the solidarity of the constituent cells of one organism; they may be assumed as agents of

[1] On this subject see Mr. Sorby's recent Presidential Address to the Royal Microscopical Society, in "Quarterly Journal of Microscopical Science," April, 1876.

a peculiar kind of infection,[1] by means of which the molecular condition or force affection of one cell is communicated to others at a distance in the same organism. It is difficult without some such hypothesis of an active material exchange of living molecules between the various cells of the body, to conceive of the way in which "change is propagated throughout the parental system," or a modified part is to "impress some corresponding modification on the structures and polarities" of distant units, such, for example, as those contained in the mammalian ovum.

In the human ovary no egg-cells are produced after the age of two and a half years. Each of the many hundred eggs there contained reposes quietly in its follicle, whilst the growth and development of other organs is proceeding. Then a renewed period of activity for the ovary commences, but the majority of the originally-formed egg-cells retain their vitality and form-individuality for more than forty years. How, we may ask, during that time are they subjected to the influence of new polar forces acquired by the other units of the body? We know that they are so impressed, or have such influences propagated to them. Is it by "action at a distance," or by the contact action of circulating infective gemmules?

Such being the state of speculation, in England at any rate, with regard to the mechanical explanation of heredity, we return to Prof. Haeckel's recently enunciated theory of the Perigenesis of plastidules.

It is clear, to begin with, that Prof. Haeckel has either never studied or has forgotten Mr. Herbert Spencer's writings. His attempt to substitute something better for Mr. Darwin's provisional hypothesis of Pangenesis, as he tells us, has its origin, to a great extent, in the admirable popular lecture of Prof. Ewald Hering of Prague, "Über das Gedachtniss als eine allgemeine Function der organisirten Materie" [On Memory as a General Function of Organised Matter], published in 1870, and to some extent, including terminology, is based on an essay by Elsberg, of New York, published in the *Proceedings* of the American Association, Hartford, 1874. With the latter of these publications I am only acquainted through Prof. Haeckel's citations, but with the former at first hand. Prof. Hering gives a brief outline in the lecture in question, of the fundamental doctrine of physiological psychology, which had been previously worked out to its consequences on an extensive scale, by Mr. Herbert Spencer. Prof. Hering has the merit of introducing some striking phraseology into his treatment of the subject, which serves to emphasise the leading idea. He points out that since all transmission of "qualities" from cell to cell in the growth and repair of one and the same organ, or from parent to offspring, is a transmission of vibrations or affections of material particles, whether these qualities manifest themselves as form, or as a facility for entering upon a given series of vibrations, we may speak of all such phenomena as "memory," whether it be the conscious memory exhibited by the nerve-cells of the brain or the unconscious memory we call habit, or the inherited memory we call instinct; or whether again it be the reproduction of parental form and minute structure. All equally may be called "the memory of living matter." From the earliest existence of protoplasm to the present day, the memory of living matter is continuous. Though individuals die, the universal memory of living matter is still carried on.

Prof. Hering, in short, helps us to a comprehensive conception of the nature of heredity and adaptation by giving us the term "memory," conscious or unconscious, or the continuity of Mr. Herbert Spencer's polar forces or polarities of physiological units.

[1] It is a striking exemplification of the unity of biological science that we should have to look to the pathologist for the next step in this region of speculation, and that fermentations, phosphorescence, fevers, and heredity, should be simultaneously studied from a common point of view with psychology.

Elsberg appears (though this is only an inference on my part) to be acquainted with Mr. Herbert Spencer's hypothesis of physiological units. Adopting Haeckel's useful term "plastid" for a corpuscle of protoplasm (cell or cytod), he designates the physiological units "plastidules," a name which Haeckel has accepted, and which may very possibly be found permanently useful. But Elsberg does not appear to have helped on the discussion of the subject to a great extent, since he proceeds no further than is implied in adopting Mr. Darwin's theory of Pangenesis, whilst substituting the "plastidules" for Mr. Darwin's "gemmules." It appears to me that Elsberg, in his combination of the Spencerian and Darwinian hypotheses, has omitted the sound element in the latter, and retained the more questionable. He should have conjoined Mr. Herbert Spencer's conception of "plastidules" possessing special polarities or force affections which they are capable of propagating as *changes* of state (*i.e.*, force-waves) to associated plastidules, and so to offspring with Mr. Darwin's conception of a universal and continuous emission of such changes from all the cells of an organism, and the frequent occurrence of a persistently latent condition of those changes—a condition which Hering's happy use of the term "memory" enables us to illustrate by the analogous (or we should rather say identical) "latent" or "dormant condition" of mental impressions.

This is, in fact, the position which Prof. Haeckel takes up—though independently of what Mr. Spencer has written on the subject, excepting so far as the influence of the latter is to be traced in Elsberg's essay. For Haeckel, living matter, protoplasm, or plasson consists of definite molecules—the plastidules which cannot be divided into smaller plastidules, but can only be split into lower chemical compounds. What Mr. Spencer calls polarities or polar forces Haeckel speaks of as "undulatory movements"—a symbol which has the advantages and disadvantages of analogy, but which, like "polarity," is *only* a symbol, and covers our incapability of conceiving more definitely the character of the phenomenon it designates. The undulatory movement of the plastidules is the key to the mechanical explanation of all the essential phenomena of life. The plastidules are liable to have their undulations affected by every external force, and once modified the movement does not return to its pristine condition. By assimilation they continually increase to a certain point in size, and then divide, and thus perpetuate in the undulatory movement of successive generations the impressions or resultants due to the action of external agencies on individual plastidules. This is Memory. All plastidules possess memory—and Memory, which we see in its ultimate analysis is identical with reproduction, is the distinguishing feature of the plastidule; is that which it alone of all molecules possesses in addition to the ordinary properties of the physicist's molecule; is in fact that which distinguishes it as vital. To the sensitiveness of the movement of plastidules is due Variability—to their unconscious Memory the power of Hereditary Transmission. As we know them today, they may "have learnt little and forgotten nothing" in one organism, "have learnt much and forgotten much" in another, but in all, their Memory, if sometimes fragmentary, yet reaches back to the dawn of life on the earth.

E. Ray Lankester

Addendum.—It will interest many readers to know that Prof. Haeckel takes an opportunity in this pamphlet of referring to Bathybius. He does not allude to the report from the *Challenger*, to the effect that Bathybius is a gelatinous precipitate of sulphate of lime, but speaks of it as of old. He draws attention to the recent observations of an excellent naturalist, Dr. Bessels, who, I find, in the *Jenaische Zeitschrift*, 1875, vol. ix. p. 277, writes as follows:—"During the last American expedition to the North Pole, I found, at a depth of ninety-two fathoms in

Smith's Sound, large masses of free, undifferentiated, homogeneous protoplasm which contained no trace of the well-known coccoliths. On account of its truly Spartan simplicity, I called this organism, *which I was able to observe in the living state*, 'Protobathybius.' It will be figured and described in the Report of the expedition. I will merely state here that these masses consisted of pure protoplasm, with only accidental admixture of calcareous particles, such as formed the sea-bottom. They formed exceedingly viscid, net-like structures, which exhibited beautiful amœboid movements, took in carmine-particles as well as other foreign bodies, and showed active granule-streaming."

This is certainly a very deliberate and definite statement on the part of Dr. Bessels, who is a well-known and accomplished observer. It will be interesting to see how these observations can be reconciled with the view taken by Sir C. Wyville Thomson and Mr. Murray.

DINNER TO THE "CHALLENGER" STAFF

ON Friday last, Sir C. Wyville Thomson and other members of the *Challenger* staff were entertained at dinner in the Douglas Hotel, Edinburgh, by a large and distinguished company. Besides the civilian chief himself, the other members of the staff present were Mr. J. Y. Buchanan, Mr. J. Murray, Lieut. Balfour, Dr. Crosbie, and Paymaster Richards. The Lord Provost occupied the chair, the croupiers, as the vice chairmen are called in Scotland, being Professors Huxley and Turner. The speeches were unusually happy and spirited, but we have space to give only a few quotations from that of Prof. Huxley in proposing the health of the scientific staff of the *Challenger*, and their director, Sir C. W. Thomson. After referring to previous Government expeditions for ocean exploration, Prof. Huxley pointed out that the peculiarity of the *Challenger* Expedition was that in her case the cruise became secondary and the scientific object primary; that she was, in fact, fitted up and instructed with the view of obtaining certain scientific data which were requisite for the further progress of natural knowledge. In her case the duty of geographical exploration was reduced to *nil*, and the duty of scientific investigation had become paramount.

After showing the great importance of a knowledge of the nature of the sea-bottom, Prof. Huxley went on—

"Thirty years ago it would have been absolute madness for anyone—I was going to say—to have hoped to obtain any knowledge of the nature of the sea-bottom or of the things which lived there at depths of 5,000, 6,000, 15,000, or 20,000 feet. But then here comes one of those admirable examples of the way in which the theoretical life of this world and the practical life interlock with one another, and interact with one another. Theoretical science, abstract investigation, carried on without reference to any practical aim whatever, that sort of abstract investigation which recent Acts of Parliament have endeavoured to throw a slur upon in this country, though I am happy to say that that has been removed in the House in which it originated—that kind of abstract investigation without immediate practical result, gave us the electric telegraph. When the electric telegraph was got, practical men desired to use it as a means of connecting remotely removed countries. For that purpose it was necessary to lay submarine telegraphs. For that purpose it was necessary to improve our means of sounding; and so out of the electric telegraph came those means of sounding at great depths of the sea, which have enabled us, for the first time, to bring up from the bottom, from a depth of two or three, or it may be four miles of sea-water, the actual things which are to be found at that enormous depth. That took place twenty years ago. In 1858, my friend Commander Dayman was engaged in the survey of the Atlantic for the purposes of the cable; and the Americans, who joined in the like service, had invented means by which specimens could be brought up from that depth. So that, if I may so say, ten years ago it was in the air to apply those new methods supplied by practical life to scientific purposes, to apply the methods of sounding, the methods of dredging, and the methods of ascertaining temperature which had been devised for the purposes of the telegraph engineer, to further investigation of the contents and nature of the sea. But it is all very well for ideas to be in the air. It needs clear brains to get them out of the air, and in this case there were two very clear brains at work on the subject—one of them the brain of our distinguished guest of to-night, Sir C. Wyville Thomson—and the other the brain of my friend Dr. Carpenter, who is well known to the scientific world."

Prof. Huxley then referred briefly to the history of recent deep-sea exploration and to the influences brought to bear on the Admiralty to send out the *Challenger*. He spoke of the object of the expedition and of the important results which have been achieved. "It was a very considerable task," he said, "it was a task which would have been absolutely chimerical thirty years ago, but it was a task which had been rendered possible, and which has been actually performed in the most satisfactory manner. The *Challenger* has brought home, I am informed, the records of such operations performed at between 300 and 400 stations—that is to say, at 300 or 400 points along that 70,000 miles, we know exactly the depth of the sea, the gradations of temperature, the distribution of superficial life, and the nature of what constitutes the sea-bottom; and such a foundation as that for all future thought upon the physical geography of the sea up to this moment not only had not existed, but had not even been dreamed of. I won't detain you by speaking of the great results of the expedition, for one very good reason, that I don't know them. They are in the breast of my friend at the opposite end of the table. But he has been good enough to favour us at the Royal Society from time to time with reports of what he has been about, and some of the discoveries which have been made by the *Challenger* are undoubtedly such as to make us all form new ideas of the operation of natural causes in the sea. Take, for example, the very remarkable fact that at great depths the temperature of the sea always sinks down pretty much to that of freezing fresh water. That is a very strange fact in itself, a fact which certainly could not have been anticipated *à priori*. Take, again, the marvellous discovery that over large areas of the sea the bottom is covered with a kind of chalk, a substance made up entirely of the shells of minute creatures—a sort of geological shoddy made of the cast-off clothes of those animals. The fact had been known for a long time, and we were greatly puzzled to know how those things got to be there. But the researches of the *Challenger* have proved beyond question, as far as I can see, that the remains in question are the shells of organisms which live at the surface and not at the bottom, and that this deposit, which is of the same nature as the ancient chalk, differing in some minor respects but essentially the same, is absolutely formed by a rain of skeletons. These creatures all live within 100 fathoms of the surface, and being subject to the fate of all living things, they sooner or later die, and when they die their skeletons are rained down in one continual shower, falling through a mile, or couple of miles of sea-water. How long they take about it imagination fails one in supposing, but at last they get to the bottom, and there, piled up, they form a great stratum of a substance which, if upheaved, would be exactly like chalk. Here we have a possible mode of construction of the rocks which compose the earth of which we had previously no conception. But this is by no means the most wonderful thing. When they got to depths of 3,000 and 4,000 fathoms, and to 4,400 fathoms, or about five miles, which was the greatest depth at which the *Challenger* fished anything from the

bottom—and I think a very creditable depth too—they found that, while the surface of the water might be full of these calcareous organisms, the bottom was not. There they found that red clay so pathetically alluded to by my friend on the right [Commander Stewart, who replied for the Navy] as the material to which when glory called him he might be reduced. This red clay is a great puzzle—a great mystery—how it comes there, what it arises from, whether it is, as the director has suggested, the ash of foraminiferæ; whether it is decomposed pumice-stone vomited out by volcanoes, and scattered over the surface, or whether, lastly, it has something to do with that meteoric dust which is being continually rained upon us from the spaces of the universe—which of these causes may be at the bottom of the phenomenon it is very hard to say; it is one of those points on which we shall have information by-and-by. I will not detain you further with speaking of the matters of interest which have come out of this cruise of the *Challenger*; I will only in conclusion remind you that work of this kind could by no possibility be done without the zealous aid of an intelligent executive. That is the first condition, but our thanks have already been rendered to the executive officers of the *Challenger*. In the second place, it could only have been done by the aid of such a scientific staff, composed of picked men as was sent out in the *Challenger*, such men as Buchanan, Murray, and Moseley, and Wild, and Suhm; and I can hardly mention the name of the last gentleman without, in passing, lamenting that he alone of all the staff who left our shores,—he who certainly was the last person we should have imagined we should not see again—that a man of his accomplishments and promise and geniality and lovability should be the only one not to be welcomed back by the friends who loved him, and by the country which would have been glad to adopt him. But, again, a work such as has been done by the *Challenger* could only have been effectively carried out under the direction, not only of a man who intellectually knew what he was about, but whose moral qualities were such as to get the people with whom he was associated to work with him."

Prof. Huxley concluded by referring to the harmony which throughout prevailed among the staff of the *Challenger*.

"When men are shut up together in a limited society, whether it be a cathedral town or a ship, they begin to hate one another unless the bishop is a very wise person. In this case I do not doubt that the bishop was a very wise person, and I do not believe that the whole course of the *Challenger* afforded occasion for any such triangular duels as one hears of in the novels of Captain Marryat."

Sir C. Wyville Thomson made a suitable reply to the toast, giving a brief account of the various operations of the *Challenger*, and referring to the great amount of work yet to be done ere all the results could be given to the world.

PHOTOGRAPHIC PROCESSES[1]

IT is not my intention to enter into the history of any of the processes to which I propose to call your attention to-night, as I somewhat dread to enter upon such controversial ground. Probably the demonstration of the production of photographic prints by various methods will be of greater interest than any history.

Astronomy was the religion of the world's infancy, and it can hardly be a matter of surprise that untutored yet inquiring minds, unaided by any distinct revelation, should have attributed to the glorious orb, the centre of our solar system, the possession of divine attributes, and as they gazed upon the wondrous effects of his magical painting, that they should have offered to him their adoration and worship, and carefully noted any phenomena due to him. Thus probably the first photographic action noticed would be at a very early period of human existence, when the exposure of the epidermis to his rays caused what is known to us as tan, whilst the parts of the body covered would remain of their pristine whiteness. A photographic action which would be remarked at a later date would be the fading of colours in the sunlight. Ribbons, silks, curtains, and similar fabrics of a coloured nature undergo a change in tint when exposed to it.

I have here a specimen of a pink trimming used by the fair sex, and the lady who presented me with it informed me that it was "a most abominable take in," as the colour "goes" after two days' wear. Her ideas on the subject and my own somewhat differed, for to me it presented a capital opportunity of using the material as a means for obtaining a photographic print in a moderate time. I have here two results of the exposure of this stuff to the sunlight. One was exposed beneath a negative of an anatomical subject, and we have the image represented as white upon a pink ground. The other subject is a map. An ordinary map was superposed over a square piece of the stuff, and placed in sunlight whilst in contact. We have in this case the lines of the map represented as pink on a white ground, from which the colour had faded.

The general opinion is, I believe, that the colour is given off somewhat similarly to the scent from a rose. Were this entirely the case, the light would not act as it does, but beneath the negative or map, the colour would bleach uniformly. The bleaching seems to be a really chemical change in the dye due to the impact of light. There are many other bodies besides dyes which change in light, and some of them are of the most unlikely nature. I had intended to show you to-night the change that takes place in glass by exposure to light for long periods. My friend, Mr. Dallmeyer, has in his possession specimens of brown and flint glass, which have markedly changed colour in those halves of the prisms purposely exposed to solar influences. In some cases there is a "yellowing" of the body, and in others a decided "purpling."

It is, however, only those bodies which change rapidly in the light that are utilised in photography. The most common amongst these are various compounds of silver, for they are peculiarly sensitive to the action of light. Nearly every silver compound is more or less changed by it, and when I say changed I mean altered in chemical composition. When we reflect what light is we can better understand its action. Light, as experiment, confirmed by mathematical investigation, tells us, is caused by a series of waves issuing from the luminous source, not, indeed, trembling in our tangible atmosphere, but in a subtler and infinitely less dense medium, which pervades all space, and which exists even in the interior of the densest solids and liquids. These waves of ether, as this medium is called, batter against and try to insinuate themselves amongst the molecules of any body exposed to their action, a good many millions of millions of them impinging every second against it. Surely it is not surprising to think, small though the lengths of these waves be, that this persistent battering should in some instances be able to drive away from each of the molecules some one of the atoms of which they are composed.

Take as a type that salt of silver which was, perhaps, the first known to change in the presence of light-silver chloride. For our purpose we may represent each of its molecules as made up of two atoms of silver locked up with two atoms of chlorine. Let us consider the action of the light on only one molecule. The waves strike against it energetically and persistently; the swing that the molecule can take up is not in accord with the swing of the ether. It is shaken and battered till it finally gives up one atom of chlorine; the vibration of the remaining two atoms of silver and one of chlorine are of a different period, and are not sufficiently in discord to cause a further elimination of an atom. The molecule which contains the two atoms of silver and one of chlorine is called a sub-chloride of silver or argentous chloride, and is of a grey violet colour. If, then, I place silver chloride (held in position by a piece of paper) beneath a body, part of which is opaque and part transparent, and expose it to sunlight, I shall find that where the opaque parts cover it, there the white chloride will remain unchanged, whilst on the portions beneath the transparent parts, the dark silver sub-chloride will have been formed. Of course were the paper, after removal of the body, to be further exposed to light, the image obtained would disappear, as a blackening over the whole surface would ensue. In this state, then, the print is not permanent. Fortunately for photography, a ready solvent of silver chloride was

[1] Lecture by Capt. Abney, R.E., F.R.S., at the Loan Collection, South Kensington.

found by Sir John Herschel in sodium-hyposulphite. On applying this salt to the image, it was removed, and also one atom of silver and one of chlorine from the sub-chloride molecule, leaving the atom of metallic silver behind. The chemical change that takes place on the silver chloride can be very distinctly shown by exposing it perfectly pure beneath water. The presence of the sub-chloride is shown by the colour, and that of the chlorine can be exhibited by the usual chemical tests.

In making an ordinary silver print on paper, we have, however, something more present than silver chloride; we have an organic salt known as the albuminate of silver, that is, a combination between albumen and silver. I have in this test-tube a little dilute albumen—the solid constituent of the white of an egg. Into it I drop a little silver nitrate: a flocculent precipitate is at once apparent. The silver from the nitrate has combined with the albumen, and on burning a piece of magnesium wire before it the outer surface shows a darkening; evidently, then, the albuminate of silver is decomposed by light. For silver printing purposes, paper is coated on one surface with a solution of albumen and sodium chloride, and the production of the silver chloride and albuminate is effected by floating that surface on a solution of silver nitrate. When dry, the paper which is now sensitive to light is ready for exposure beneath a negative. Here we have two prints produced on paper so prepared. If now I take one of them and dissolve away the insoluble salts in sodium hyposulphite, you see that the colour is of a disagreeable foxy-red tint. To show you how this want of a pleasing tone may be overcome, the other print is immersed in a weak solution of gold, and by a well-known chemical action the metallic gold is deposited on the darkened portions of the picture. Now when gold is precipitated, it has not the well-known yellow colour, but is of a bluish purple; thus the deposited gold mixes its peculiar tint with that of the silver, and after immersion in the hyposulphite we obtain a print whose beauty cannot be surpassed.

I daresay that many of you may have been charmed with the production of magic photographs, as they were called. Some few years ago the sale of such was enormous, but now the curiosity of the public seems to be satiated. The magic, as you may be aware, consisted in being able to produce on a white piece of paper a photograph of some unknown object. These mysterious pieces of paper were generally supplied in packets, containing with them a piece of blotting-paper. The directions stated that the blotting-paper was to be damped, and whilst moist, to be applied to the surface of one of the accompanying pieces of blank paper, and then a photograph would shoot out. I will endeavour to show you one method of their production. Here I have an ordinary photographic print which has not been treated with gold, but merely immersed in sodium hyposulphite and then washed. I immerse it in a solution of mercurous chloride which I have in this dish, and immediately a bleaching action is set up. The action continues, and the paper is apparently blank. What has happened? Simply a white compound of silver and mercury has been formed, which is indistinguishable from the paper. If I wash the paper and dry it, it is in the state of the paper supplied in the packets. I have one here washed and dried, and I immerse it in the sodium hyposulphite. The image immediately reappears, a combination has taken place between the constituents of the hyposulphide, the mercury, and the silver.

Need I say that the blotting-paper supplied is impregnated with the same sodium salt? In damping it the molecules of the latter are so separated and mobile, that they are free to combine with the white image. By similar treatment the picture may be made to again disappear and once more reappear.

Besides silver there are various other metals which will give a photographic image. This paper, which has a slightly yellow tint, has been brushed over with ferric chloride, more commonly known as perchloride of iron, in which we have the maximum number of colours of chlorine combined with metallic iron. Allowing ordinary white light to act upon it, the waves cause a disturbance between the iron and the chlorine atoms, and one of the latter is shaken off, leaving ordinary ferrous chloride, or muriate of iron behind. A piece of paper, similarly prepared, has been exposed beneath a negative, and the reduction of the ferric chloride to the ferrous state can be demonstrated by floating it on a solution of potassium ferricyanide. The combination between the lowest type of the iron salt and this salt results in the formation of a deep blue precipitate known as Turnbull's blue. You see, after applying it, we have the lines of this map, of which this is the negative, of an intense blue. Instead of demonstrating the change of the iron salt by this means, I may float it on a weak solution of silver nitrate. The ferrous salt of iron will reduce the silver, whilst the ferric salts are wholly inoperative to produce the same effect. Here we have such a print.

The principal investigator of the action of light on iron compounds was Sir John Herschel, and he employed a variety of different combinations. Perhaps one of the most interesting exhibits in the Photographic Section is that old list of Fellows of the Royal Society on which were pasted, by the hand of that distinguished philosopher, the actual solar spectrum prints made during his researches on these and other metallic salts.

Uranium salts are also capable of being reduced to less complex forms by the action of light. I will not enter into a detailed description of the decomposition, but will simply exhibit the method of producing a print with the salt. The paper has been coated with uranic nitrate and exposed to light, beneath the same negative before shown to you. The image is made visible by a solution of potassium ferricyanide, as in the case of the iron salt.

In the cases of photographs are shown some interesting specimens of iron and uranium prints, made by Nièpce de St. Victor. I believe they were presented to Sir Charles Wheatstone by that ardent experimentalist. The subdued brown tones of the latter were probably obtained by the admixture of a little iron with the uranium.

Within the last couple of years the salts of iron have been put to practical photographic printing purposes by Mr. W. Willis, jun., of Birmingham, and a valuable process has resulted from his labours. The sensitive salt employed is an organic salt of iron known as ferric oxalate, and Mr. Willis made the discovery that amongst other metals platinum could be reduced to the metallic state from a double chloride of potassium and platinum, by ferrous oxalate in the presence of a potassic oxalate. A piece of paper is floated on a weak solution of silver nitrate and dried; and over the surface is brushed a mixture of the platinum salt and the ferric oxalate. After exposure to light (which produces the ferrous salts) beneath a negative, the paper is floated on a solution of neutral potassium oxalate, when the image at once appears formed of platinum black, a substance at once durable and incapable of being acted upon by atmospheric influence. Such an exposed paper I have here, and floating it on oxalate solution, you see the image is immediately developed. The unreduced iron salt can be eliminated by soaking the print in the oxalate solution, and a rinse and hyposulphite removes all traces of silver nitrate. After a few changes of water, the print may be dried, and is permanent. I should explain that the paper is first coated with silver nitrate in order to cause the platinum to adhere firmly to the surface of the paper. When omitted, the fine black powder formed is apt to precipitate in the bath.

Before dwelling upon that metallic compound which in photography is next in importance to silver, I must call your attention to the first vanadium print ever produced. Prof. Roscoe, who has already delighted an audience in this room with an admirable lecture on Dalton's apparatus and what he did with it, has made a classical investigation of the compounds of this metal, and amongst other interesting facts, has noticed that the vanadium salts are reduced by light in a somewhat similar manner to the uranium salts.

We now have to consider the printing processes which are due to the action of light on the dichromates of the alkalis in the presence of organic matter. For our purpose to-night we may take as a type potassium dichromate, a salt which readily parts with its oxygen to those compounds that have an avidity for it, more especially to certain carbon compounds under the influence of the ether waves.

To show that this salt is thus easily reducible by light in the presence of organic matter, I have here a piece of paper which has been brushed over with it, and exposed beneath a print. For a moment I float it on a weak solution of silver nitrate. The brilliant crimson colour of the part not exposed to light tells us that silver dichromate has been formed, but where the solar rays have acted, the colour remains unchanged. A slight modification of this process now exhibited to you is known as the chromatype, the offspring of Mr. Robert Hunt, so well known in the scientific world for his researches on light. Whilst experimenting with the chromatype process, Mr. W. Willis, the father of the gentleman I have already mentioned, discovered what is known as the aniline process. It is based on the fact that an acid in the presence of potassium

dichromate strikes a blackish green or red colour when brought in contact with aniline. You will see the *modus operandi* when I say that paper is floated with potassium dichromate and a trace of phosphoric acid. Aniline is dissolved in spirits of wine, and the mixed vapours allowed to come in contact with the sensitive paper that has been exposed beneath a positive print, such as a map or plan. The impact of the light has so changed the potassium salt, that the aniline vapour causes but little coloration, whilst where the paper has been protected from it, the dark colour indicates that the dichromate is unchanged. The formation of this black colour is familiar to the manufacturers of aniline colours, being, I believe, similar in composition to the residue left after the formation of aniline purple by Mr. Perkins's method.

It should be noted that for copying engineers' tracings and drawings this process is extremely valuable, as there is no occasion to take a negative on glass before obtaining a print. All that is requisite is that the original should be fairly penetrable by light. A piece of paper prepared as indicated, a sheet of glass to place over the plan, and a box in which to place the exposed print to the aniline vapour are the only necessary plant for the reproduction of a design.

(*To be continued.*)

NOTES

THE following are the officers of the forty-sixth annual meeting of the British Association which will commence at Glasgow on Wednesday, September 6, 1876:—President-designate—Prof. Thomas Andrews, M.D., LL.D., F.R.S., Hon. F.R.S.E., in the place of Sir Robert Christison, Bart., M.D., D.C.L., F.R.S.E., who has resigned the Presidency in consequence of ill health. Vice-Presidents elect—His Grace the Duke of Argyll, K.T., F.R.S., &c., the Lord Provost of Glasgow, Sir William Stirling Maxwell, Bart., M.A., M.P., Prof. Sir William Thomson, D.C.L., F.R.S., &c., Prof. Allen Thomson, M.D., LL.D., F.R.S., &c., Prof. A. C. Ramsay, LL.D., F.R.S., &c. General Secretaries—Capt. Douglas Galton, C.B., D.C.L., F.R.S., &c., Dr. Michael Foster, F.R.S. Assistant General Secretary—George Griffith, M.A., F.C.S. General Treasurer—Prof. A. W. Williamson, Ph.D., F.R.S. Local Secretaries—Dr. W. G. Blackie, F.R.G.S., James Grahame, J. D. Marwick. Local Treasurers—Dr. Fergus, A. S. M'Clelland. The Sections are the following:—Section A: Mathematical and Physical Science. President—Prof. Sir W. Thomson, D.C.L., F.R.S. Section B: Chemical Science. President—W. H. Perkin, F.R.S. Section C: Geology. President—Prof. J. Young, M.D. Section D: Biology. President—A. Russell Wallace, F.L.S. Department of Anthropology, A. Russell Wallace, F.L.S. (President), will preside. Department of Zoology and Botany, Prof. A. Newton, F.R.S. (Vice-President), will preside. Department of Anatomy and Physiology, Dr. J. G. M'Kendrick (Vide-President), will preside. Section E: Geography. President—Capt. Evans, C.B., F.R.S., Hydrographer to the Admiralty. Section F: Economic Science and Statistics. President—Sir George Campbell, K.C.S.I., M.P., D.C.L. Section G: Mechanical Science. President—C. W. Merrifield, F.R.S. The First General Meeting will be held on Wednesday, Sept. 6, at 8 p.m. precisely, when Sir John Hawkshaw, C.E., F.R.S., will resign the chair, and Prof. Andrews, F.R.S., President Designate, will assume the Presidency, and deliver an Address. On Thursday evening, Sept. 7, at 8 p.m., there will be a *soirée*; on Friday evening, Sept. 8, at 8.30 p.m., a Discourse; on Monday evening, Sept. 11, at 8.30 p.m., a Discourse by Prof. Sir C. Wyville Thomson, F.R.S.; on Tuesday evening, Sept. 12, at 8 p.m., a *soirée*; on Wednesday, Sept. 13, the Concluding General Meeting will be held at 2.30 p.m. The Local Committee, as our readers will have seen from a previous report, have made unusual exertions to render the Glasgow meeting a success. A variety of interesting collections will be exhibited, and the excursions which have been already arranged for will doubtless form one of the most attractive, and not the least instructive, feature of the meeting.

IT is with sincere regret that we notice the announcement in *L'Explorateur* of the death of the eminent and well-known geographer, Dr. August Heinrich Petermann, at the early age of fifty-four years. He was born April 18, 1822, at Bleicherode, in Prussian Saxony. In 1839 he became a pupil of the special Academy founded at Potsdam by the geographer Berghaus, whose secretary and librarian he was for six years, as well as *collaborateur*, for he took an active part in the preparation of the great Physical Atlas of his master; the English edition, which appeared at Edinburgh in 1847, even bore his name. In 1845 he left Germany for Edinburgh, after two years' stay in which city he went to London, where he became a Fellow of the Royal Geographical Society. He wrote many valuable articles on the Progress of Geography, in the *Athenæum* and the "Encyclopædia Britannica," published the "Atlas of Physical Geography" in conjunction with the Rev. Thomas Milner, and a *Tableau* of Central Africa according to the most recent explorations. It was greatly due to his influence that the English Government entrusted to the German travellers Barth, Overweg, and Vogel, missions fruitful in results both to science and commerce. Petermann also, as our readers know, paid great attention to questions connected with the Arctic regions, though his opinions on certain points connected with Arctic geography are not likely to be confirmed. Still he did excellent service in this department by advocating the equipment of expeditions private and governmental, and by recording speedily and accurately the results from time to time obtained. In 1854, Petermann accepted the chair of geography in the University of Gotha, and in 1855 received from the University of Gottingen the degree of Ph.D. It was at this time that he undertook the direction of the great geographical establishment of Justus Perthes, of Gotha, and commenced to edit the well known *Mittheilungen*, the monthly geographical review, whose scientific value has been long recognised. Petermann had a comprehensive idea of what is included under geographical science, and it will be difficult to supply his place either as editor of the *Mittheilungen*, or in the department of scientific geography.

MR. CROSS on Monday received a very numerous deputation from the British Medical Association, who laid before him their views with regard to the Vivisection Bill now before Parliament. These opinions were conveyed by Mr. Ernest Hart, Mr. John Simon, Dr. Wilks, senior physician of Guy's Hospital, and Sir W. Jenner, who raised his voice against a measure which would place men of science under police supervision, and would lay a ban upon them for inflicting cruelties on the lower animals when ten thousand times greater cruelties were inflicted by those who were going to pass this Bill. Such conduct would make those who passed it objects of scorn to all the scientific men in Europe. The Home Secretary, in reply, pointed out that the Bill was framed practically in accordance with the views of the Royal Commission, and that whether the Bill passed now depended entirely upon the line of conduct pursued by the medical profession.

WE are compelled by a pressure on our space to postpone the continuation of Dr. Richardson's articles till next week.

THE Kew museums have recently acquired some interesting additions to their already unique and valuable collections by the presentation, by his Royal Highness the Prince of Wales, of the botanical specimens collected during his recent visit to India. These specimens consist of a number of seeds and fruits of economic or medicinal value, as well as of condiments, drugs, gums, &c., from Southern India, and a series of named woods from Kanara. Though most of the seeds, fruits, and gums are already contained

in the Kew collection, so rich is it in Indian and Colonial products, some are nevertheless absolutely new, and many of them are fresher than those which have been contained in the Museum for some years.

M. RAFFRAY, we learn from *L'Explorateur*, entrusted with a scientific mission by the French Minister of Public Instruction, proposes to explore the Sunda Islands and New Guinea, especially in relation to their natural history. He takes with him as assistant, M. Maurice Maindrow, of the Entomological Laboratory of the Paris Museum. The explorers will embark at Toulon on the 20th inst. for Singapore, in a government vessel. From Singapore, M. Raffray will proceed by Batavia to Ternate and the island of Waigiou, where the two explorers intend to sojourn till the spring of next year. Proceeding then to Dorey, they will endeavour to land on the coast of the Aropin country, on the south of Geelvincks Bay, a region which has not been visited by the Italian explorers, Beccari and D'Albertis. M. Raffray expects his expedition to last for two or three years, according to the state of his health.

SIGNOR D'ALBERTIS and party have left Somerset on their way to New Guinea; they have a steam launch with them.

MR. ERNEST GILES, the Australian explorer, was last heard of at Mount Murchison on April 10, when all was well. Mr. Giles expected to reach Beltana, South Australia, about September.

IN reference to our article on the Tasmanians last week, we learn that that people are not quite extinct, though nearly so. It appears by a letter from M. Castelnau, French Consul at Sydney, to the Geographical Society of Paris, read at its last sitting, that the only four Tasmanians living were presented at the last levée held by the Governor of Tasmania. The *Times* of last Thursday intimated the death of another last Tasmanian; but evidently we have not yet seen the end of them.

WE are glad to see that the subscription for the proposed memorial to the late Mr. Daniel Hanbury is progressing; there is already a considerable list of subscribers, but there is room for many more. The memorial, as we have already intimated, is to be a gold medal, to be awarded for high excellence in the prosecution or promotion of original research in the natural history and chemistry of drugs. Subscriptions should be sent to the hon. secretaries to the fund, 17, Bloomsbury Square, W.C.

A MEETING has been held to promote a memorial to the late Dr. Parkes, F.R.S. It is hoped that a sufficient sum of money may be collected to establish a museum and laboratory of hygiene similar to those now existing at Netley.

THE Council of the Royal School of Mines have awarded the Royal Scholarships for first-year students to T. E. Holgate and F. G. Mills; the Royal Scholarship for second-year students to A. N. Pearson; the De la Beche Medal and Prize for Mining to H. Louis; the Murchison Medal and Prize for Geology, and the Edward Forbes Medal and Prize for Natural History and Palæontology, to W. Hewitt. The following have obtained the Associateship of the school during the past session (1875-76):—W. Hewitt, C. V. Boys, J. de Goncer, F. E. Lott, H. Louis, E. F. Pittman, E. B. Pressland, J. H. Barry, A. J. Campbell, P. de Ferrari, M. H. Gray, H. Gunn, W. Howard, A. B. Kitchener, W. F. Ward.

CAPT. MOUCHEZ sent to Amsterdam and St. Paul Island, some time since, a trading-vessel, in order to collect specimens of natural history to complete the collections made during the Transit of Venus expedition. The ship was wrecked on Amsterdam Island, and the crew were drowned, the captain only being saved. He remained for two months on the island, and was rescued by a Norwegian whaler. But during his forced stay in that solitude, Capt. Herman did not lose sight of the objects of his mission, and devoted to it all the time he was not obliged to devote to obtain food and shelter. All the objects collected under such peculiar circumstances have been sent to France by the Messageries Nationales, and are expected to arrive by their next steamer.

MR. FLOYD (not Lloyd), the President of the Board of Trustees for the Lick Donation, has come to an arrangement with M. Leverrier for the better execution of the contemplated instruments for the Paris and San Francisco Observatories. The masses of glass required are to be made in Paris, at Feil's glassworks, and the object-glasses very likely by an English optician. The French refractor is to have a double set of object-glasses, the necessary money having been given to M. Leverrier by M. Bishofsheim, one of the richest Parisian bankers, the donor of the Bishofsheim transit instrument now constructing at the Paris Observatory.

THE following are the numbers of visitors to the Loan Collection of Scientific Apparatus during the week ending July 8:—Monday, 3,211; Tuesday, 2,544; Wednesday, 607; Thursday, 609; Friday, 614; Saturday, 4,354; total, 11,939.

DURING the present week twelve demonstrations of apparatus were given at the Loan Collection on Monday, eleven on Tuesday, six on Wednesday, seven to-day; five will be given to-morrow, and seven on Saturday.

AN examination will begin on Tuesday, October 10, at Merton College, Oxford, for the purpose of electing to one Physical Science Postmastership, of the annual value of 80*l*., tenable for five years from election. The subjects of examination will be Chemistry and Physics. There will be a practical examination in Chemistry. Further information may be obtained from the tutor in Physical Science.

MR. THOMAS STEVENSON writes with reference to Mr. Kinahan's letter on sand-drift in NATURE, vol. xiv., p. 191, that from a passage in his book on "The Design and Construction of Harbours," second edition, p. 243, it will be learned that the pine planted by Lord Palmerston was the *Pinus maritima major*. In his report to Lord Palmerston in 1839, Mr. R. Stevenson recommended that this pine should be procured from France. A kind of bent grass was planted on the side next the sea, so as to act as a protection to the pines during their first growth. The result of the experiment was highly successful.

A REPORT has gone the round of the papers that the Government have recently made an offer to the Council of the Zoological Society of a strip of ground on the north bank of the Regent's Canal, on condition that the Gardens should be opened free to the public on one day in each week, and that this offer has been declined. This report is quite unfounded, the strip of land referred to having been granted to the Society in 1869. Upon it is built an aviary and the lodge in connection with the Primrose Hill gate. That a still further extension of the Gardens would be to the public gain, all visitors will no doubt testify.

HERR CARL HAGENBECK, the well-known dealer in living animals at Hamburg, has just received a large collection from Upper Nubia, amongst which are four elephants, five giraffes, and several other large mammalia. They are under the care of four Hamran Arabs, whose sword-hunting feats have been so well described by Sir Samuel Baker in his work on the Nile and its tributaries. Dressed in their native costumes and mounted on four fleet dromedaries, these Arabs cause quite a sensation among the inhabitants of Hamburg, and are of themselves, independent of the animals, well worthy of a visit from all passing in that direction.

THE living gorilla, which we referred to a fortnight ago as being at Liverpool, after travelling from Hull to Hamburg, was forwarded to Berlin, in the Aquarium of which city we believe it is to be deposited.

Mr. W. S. Ward, of the United States Executive, is now on a visit to England to make himself acquainted with the principles and construction of the most important public aquaria in this country with reference to the establishment of similar institutions on an extensive scale in New York, and other leading American cities.

Prof. H. G. Seeley has been appointed to the Professorship of Geography in King's College, London.

The Dutch Society of Sciences, Haarlem, has awarded the Boerhaave Medal to Prof. W. Hofmeister, Professor of Botany in the University of Lubingen.

We are doing a good deal, says the *Gardeners' Chronicle*, to bring scientific literature within the reach of the people, but our French neighbours are certainly ahead of us in this respect. This conviction is forced upon us by the recent purchase of a Manual of Botany of sixty-two pages for the sum of 10 centimes —a penny in English money! This closely printed little work, by one M. Anciaux, forms one of a series of similar *brochures* which is issued by M. Ad. Rion under the title of "Les Bons Livres." It contains chapters on vegetable anatomy and physiology, on botanical geography, classification, and taxonomy, and is certainly a marvel of cheapness.

M. Cezanne, the young and promising member of the French Chamber of Deputies for Hautes-Alpes has died of consumption. M. Cezanne, the author of a valuable work on the physical phenomena presented by waterfalls on mountains, was the founder and president of the French Alpine Club. His loss will be so much more heavily felt that the French Minister of Public Instruction is at present making great efforts to popularise the new institution. An official circular, published almost on the very day when M. Cezanne died, recommends the heads of the several government schools in France to organise tourists' expeditions during hot days for exploring the Alps and Pyrenees. Railway companies are to issue special tickets at exceedingly moderate rates.

The Prefect of the Seine Department has created a fund of 11,000 francs for sending to Dieppe, the seaport nearest to Paris, a number of pupils of the municipal free schools. Fifty will be selected from each school, and are to be chosen according to their merits. These tourist-laureates are to be boarded in the Dieppe College, visit surrounding places, and receive instruction in the natural curiosities or historical facts connected with the localities.

We observe from the *Bulletin Mensuel* of the Observatory of Montsouris for May that the Administration of Paris on April 11 last decided that meteorological observations be made with special reference to health in different parts of the city, and voted an annual grant of 12,000 francs to the Observatory, to which the inquiry has been entrusted. It has been resolved that the work shall embrace, in addition to the meteorological observations usually made, atmospheric electricity, and variations in the composition of the air (see ante, p. 156). In the meantime observations and experiments are being conducted at Montsouris with the view of arriving at simple practical methods of observing with scientific precision the different variable elements contained in the air, before extending the observations to the different quarters of the city. This number of the *Bulletin* details some very interesting results of elaborate observations made on the ozone, carbonic acid, and organic matters of the air of Paris, illustrated with figures of some of the more interesting organisms.

The interesting address by the senior vice-president, Mr. J. Thackray Bunce, at the last annual meeting of the members of the Birmingham Midland Institute, has been printed in a separate form. Mr. Bunce contrasts the condition of Birmingham with regard to education twenty-three years ago, when the Institute was founded, with its condition now. The contrast is very great indeed, and the Institute has no doubt done much to dispel the darkness in the midst of which it started. Mr. Bunce sketches the progress of the Institute, which is now in a most flourishing condition, and rightly urges the members to renewed efforts to make it increasingly useful.

The following additions have been made to the Royal Aquarium, Westminster, during the past week:—Picked Dogfish (*Acanthias vulgaris*); Bass (*Labrax lupus*); Streaked Gurnards (*Trigla lineata*); Sapphirine Gurnards (*Trigla hirundo*); Turbot (*Rhombus maximus*); Greater Pipefish (*Syngnathus acus*); Cornish Suckers (*Lepidogaster cornubiensis*); White Bream (*Abramis blicca*); Pope or Ruff (*Acerina vulgaris*); Zoophytes (*Alcyonium digitatum*).

The additions to the Zoological Society's Gardens during the past week include a Great-headed Maleo (*Megacephalon maleo*), from Celebes; a Bornean Fireback Pheasant (*Euplocamus nobilis*); two Common Crowned Pigeons (*Goura coronata*), from New Guinea; two Black-backed Geese (*Sarcidiornis melanota*), from India (?); a Saddle-billed Stork (*Xenorhynchus senegalensis*), from West Africa, purchased.

SOCIETIES AND ACADEMIES

London

Anthropological Institute, June 13.—Col. A. Lane Fox, F.R.S., president, in the chair.—Prof. Busk, F.R.S., described a collection of crania of natives of the New Hebrides, some of which had been sent to the president by Mrs. Goodenough, and others to the Royal College of Surgeons, by Dr. Corrie, R.N. Seven were from the Island of Mallicollo and three from that of Vanikoro. With respect to the former, he remarked that they were of special interest as being the first, so far as he was aware, that had ever been brought to Europe from that locality, and also from their extraordinary form, due to the artificial depression of the forehead, a mode of deformation not hitherto recorded among the Melanesian race of New Guinea and the South Sea. The peculiar form of the head among the Mallicollese was noticed by Captain Cook and the two Forsters on the occasion of the discovery of the Island in 1774. The skulls from Vanikoro, on the other hand, represented the normal form of the cranium in people of the same race.—A paper by Mr. Ranken on the South Sea Islanders, was read by Mr. Brabrook. The author proposed that the name Mahori should be adopted to distinguish the light races of the Pacific from the Papuans or blacks. He adduced evidence to show that the latter first occupied a considerable number of the islands, and that the lighter race arrived subsequently from the west and formed a settlement in Samoa, whence it is now well established, that they spread in all directions, and, in some instances, mingled with the Papuans. He mentioned several points in which the Mahoris differ essentially from the Malays, who, however, appear to be a cognate race.—A short account of a visit paid to New Guinea, by M. d'Albertis, was communicated by Mr. Franks.—Mr. Distant described some photographs of natives of the Nicobar Islands.

Geologists' Association, June 2.—Mr. Wm. Carruthers, F.R.S., in the chair.—Notes on the geology of Lewisham, by Mr. H. J. Johnston Travis, F.G.S. The author, after briefly alluding to that portion of the Upper Chalk which is exhibited in the excavations, proceeded to describe the Thanet Sands, and to compare this section with the neighbouring one at Charlton, where, in the Thanet Sands, casts of *Cyprina* and the vertebra of fish have recently been discovered. Referring to the well-known green-coated flints about which there has been so much controversy, he mentioned a circumstance which may be noted at the fault near St. John's Station, Lewisham. The Chalk and Thanet Sands are there faulted against each other at an angle of 40°, but the actual line of contact is now occupied by a band of flint. This shows that the chalk has been dissolved away by acidulous waters, following the fissure down to this band of flint, which has resisted further action. Portions of the same flint, where yet imbedded in the chalk, retain the usual white surface, whilst those portions projecting into the sands are green-coated. The author then instituted a close comparison between the Woolwich and Reading beds of the Lewisham and Charlton sections respectively.

Victoria (Philosophical) Institute, July 3.—A paper on the unseen universe, was read by the Rev. Dr. Irons.

BERLIN

German Chemical Society, June 12.—A. W. Hofmann, president, in the chair.—F. Sonnenschein spoke on two active principles of gelsonia sempervirens; one called gelsinic acid by Wormsley proved to be æsculine; the other, a strong but amorphous base, of which no compound seems to crystallise excepting perhaps the platinum-salt, acts like strychnine and digitaline and gives a red colour with sulphate of sesquioxide of cerium.—A. Müller reported on the ground water of Gennevilliers, the irrigation-ground of Paris, his analyses yielding less favourable results than those published in the reports of the Paris Commission. The President remarked upon the difficulty of drawing conclusions from isolated analyses, a continuation of systematical researches being absolutely necessary for the purpose.—C. J. Austen described a new dibromo-dinitro-benzol fusing at 99°. With ammonia it yields monobromo-dinitraniline. With aniline a corresponding compound originates, which yields a nitro-product capable of uniting with alkalies.—Emil Fischer and Otto Fischer have made new researches on the di-azo compounds of rosaniline, of leukaniline and of hydrocyano-rosaniline. The di-azoleukaniline yielded, with sodium, a hydrocarbon, $C_{20}H_{18}$ (corresponding to leukaniline, $C_{20}H_{16}[NH_2]_3$) fusing at 58°, distilling above 300°, and yielding, with chromic acid, a ketone, $C_{20}H_{16}O$.—Emil Fischer has combined phenyl-hydrazine, $C_6H_5N_2H_3$, with CS_2, forming $(C_6H_5N_2H_3)_2CS_2$. This body dissolves in potash, and from the solution sulphuric acid precipitates an acid, phenyl-sulpho-carbazinic acid, $C_6H_5N_2H_2$ CS.SH, while one molecule of phenyl-hydrazine is split off. This acid is easily decomposed by heat, yielding hard and colourless prisms $(C_6H_5N_2H_2)_2CS$, diphenyl-sulphocarbazid; alkali changes it into a black colouring matter, isomeric with the above and soluble in alkali with a red colour. Phenyl-hydrazine and bromide of ethyl yield a new crystalline substance,

$$C_6H_5N_2H_2(C_2H_5)(C_2H_5Br),$$

bromide of phenyl-diethyl-hydrazonium. With oil of bitter almonds phenyl-hydrazine forms crystals of the compo[...] $C_6H_5.N_2H.CH.C_6H_5$. Isocyanate of ethyl and phenyl-[...]zine form a urea of the composition $C_6H_5N_2H_2$ - CO - NH [...] With acetic anhydride and with oxalic ether, phenylhydrazine yields products in which one atom of hydrogen is replaced by acid radicals. At last the higher homologue, toluyl-hydrazine, has been prepared, $C_7H_7N_2H_3$ in the manner formerly described for preparing phenylhydrazine.—H. Vohl claims priority for a test for sulphur in organic compounds lately described by Weith.—B. W. Gerland described several sulphates of tetroxyde of vanadium as well as metavanadic acid.—H. Grunzweig and R. Hofmann defended the existence of crystallised ultramarine against some doubts lately expressed by Buchner.—H. Landolt published elaborate researches on the specific deviation of the plane of polarisation of solutions, from which he concludes that indifferent solvents affect the values observed very considerably, so that concentrated solutions only can furnish results of any approach to exactness.—E. A. Grete described a volumetric method of determining sulphuret of carbon, xanthogenic acid, alkalies, and copper, depending on the formation of insoluble xanthogenate of copper.—V. Meyer and F. Spitzer have transformed the product of the action of PCl_5 on camphor; $C_{10}H_{15}Cl$ into crystallised ethyl-terpene, $C_{10}H_{15}-C_2H_5$.

PARIS

Academy of Sciences, June 26.—Vice-Admiral Paris in the chair.—The following papers were read:—Geometric points and envelope curves satisfying the conditions of constant product of two variable segments; generalisation of some theorems expressed in radii vectors, by M. Chasles.—Note on the development of cos. mx and sin. mx, according to powers of sin. x, by M. Yvon Villarceau.—On the maximum of possible repulsive force of the solar rays, by M. Hirn. Taking (from experiment) 0·293833 cal. to represent the heating per square metre on the earth's surface, the two pressures 0·0004157 gr. and 0·0008314 gr. are necessarily the greatest possible for a perfectly absorbing and a perfectly reflecting surface; on any hypothesis attributing phenomena of light and heat to movements of ponderable matter. If, then, a radiometric or other experiment give, for solar repulsion, a value superior to those now specified, we must conclude against a direct impulsion by light, and the idea of mass, density, &c., in light. Now Mr. Crookes has estimated the apparent repulsion at 1 gr. per sq. metre, or more than a thousand times superior to the above maximum for reflecting bodies.—New experimental considerations on Mr. Crookes's radiometer, by M. Ledieu. This refers chiefly to experiments by M. Bertin, who has a paper on the subject in the June number of *Annales de Chimie et de Physique*.—Properties common to canals, rivers, and water-pipes with uniform *régime* (first part), by M. Boileau.—M. de Saporta was elected correspondent for the Section of Botany, in room of the late M. Thuret; MM. Godron and Duval Jouve were the other candidates.—Report on a memoir of M. Felix Lucas, entitled "Calorific Vibrations of Homogeneous Bodies." The chief object proposed is to deduce from thermodynamics the principles of conductivity of heat in homogeneous bodies, enunciated by Fourier, considering heat as the result of molecular vibrations.—Exposition of a new method for resolution of numerical equations of all degrees (third part), by M. Lalanne.—On a differential radiometer, by M. de Fonvie[...].—Process for the manufacture of soda from wrack by [...]tic steeping in lye, by M. Herland.—On the catastr[...] Grand Sable (district of Salazie), Isle of Réunion, [...] Vinson. The renewal of subterranean commotions in [...] volcanic action as the cause of the catastrophe.—Ele[...] ephemerides of planet 153, Atala, by M. Bossert.—On linear differential equations of the second order, by M. Fuchs.—On the contact of surfaces of an implex with an algebraic surface, by M. Fouret.—On some experiments made with Crookes's balance, by M. Salet.—On some derivatives of normal pyrotartaric acid, by M. Reboul.—Volumetric determination of formic acid, by MM. Portes and Ruyssen.—On the arragonite observed on the surface of a meteorite, by Mr. J. Lawrence Smith. It was in the form of white incrustation, on meteoric masses found in the desert of Mexico. The matter seems to have been incrusted on the iron after fall of the latter. The mass lay in a valley between high mountains of calcareous formation, and would often be washed and covered with water during heavy rains.—On the combinations of carbons found in meteorites, by Mr. J. Lawrence Smith.—On the employment of chloride of calcium in the watering of [...]menades, and public gardens, by M. Houzeau. At [...]ste product of the manufactories of pyroligneous [...]utilised in the way referred to, and with the best results. It impregnates the soil with hygrometric matter which makes durable for a week the moisture imparted. It is healthy, always containing a good deal of chloride of iron and tarry matters; and compared with water, it realises an economy of about thirty per cent. Further, it improves streets and roads by covering them with a sort of patina or hard superficial crust, resisting both desiccation and disaggregation.—Study on the formation and growth of some galls, by M. Prillieux.—Experimental researches on the action of aniline, introduced into the blood, and into the stomach, by MM. Feltz and Ritter. This inquiry was suggested by an analysis of wines sold at Nancy, which showed that fuchsine is largely employed to heighten the colour of wine, and to mark the addition of water. Its injurious action is shown on man and on dogs.—Researches on *Cypressus pyramidalis*, by M. Hartsen.—Process of registration and reproduction of colours, of forms, and of movements, by M. Cros.

CONTENTS

THURSDAY, JULY 20, 1876

THE UNIVERSITY OF MANCHESTER[1]

II.

WE have already discussed in last week's NATURE the present position of the higher education of this country, and we shall now endeavour to point out in what respect this is deficient, and in what way this deficiency may best be remedied.

One of the most important replies called forth by the pamphlet of the Senate of Owens College is that by Prof. Huxley, and this is alluded to in the following terms in a second pamphlet drawn up by members of the Senate :—

"Prof. Huxley, while holding that the increase of universities—in the proper sense of the term—is in itself desirable, questions whether the granting of degrees is essential to the character of a university. With the true honour and highest functions of a university, associated, as these are, not with its ordinary but with its choice products—with the flower of its students as they prove themselves in university and in the general national life—the power of granting degrees and the number of degrees granted are indeed not essentially concerned. But it can at the same time hardly be denied that examinations, and the preparation for examinations, are the proper channels through which the influence of teaching is brought home to the great bulk of students at any university, and that without examinations the efficiency of its teaching cannot be tested in reference to its average pupils. It is for this reason that the degree-granting power, in Dr. Carpenter's words, 'is usually held in this country to be the essential attribute of a university.' The degree is the outward sign of a standard reached ; this test the public has a claim to demand, more especially in fields of study to which no other practical test is applicable under ordinary circumstances, and this test it will continue to demand till brands go out of fashion. and till the public is composed of competent independent appraisers of proved merit."

These words embody a powerful argument in favour of keeping to our present system. When a man styles himself M.A. of Cambridge, for instance, this denotes unquestionably a certain intellectual training and acquirement, but it implies also a certain moral, social, and even physical training. It implies that during his residence at Cambridge his character was such as to satisfy the college authorities, while his social capacities must have been developed by the numerous influences of undergraduate life. The public has surely a right to demand this outward sign of a standard reached in the case of such a man—we may therefore take it for granted that in the future of this country the degree-granting power will be retained by the higher educational institutions. This preliminary question being settled in this way we must next ask whether the present degree-giving bodies of this country are, as they stand now, doing enough for our higher education, and if not, whether they can be made to do so by a legitimate extension of their present powers ; for clearly if bodies now in existence can be made sufficient for all the purposes of a higher education it would be impolitic and unnecessary to call a new institution into existence.

Now we think it cannot be denied that the present number of graduates turned annually out by the Universities of Oxford and Cambridge bears but a small proportion to the whole population of England ; nor will this be greatly modified by adding thereto the yearly result of the University of London—England will still be found deficient in comparison with other countries. One reason for this arises from locality, for even in these days of easy locomotion the element of locality retains an influence ; and we believe it has been found that the two English Universities draw the greatest relative proportion of pupils from counties in their immediate neighbourhoods, and the same may be said of the University of London. Nor is this to be wondered at, for the connection between a student and his University does not cease when he gets his degree. He only then truly begins to form a part of the institution and to take an interest in its proceedings, and he will on this, as well as on other grounds, attach himself, if possible, to a University in his immediate neighbourhood. At present, therefore, the whole north of England may be said to be without a University. Again, it may be taken for granted that the large and influential class of men residing in the great cities of the north of England who have become wealthy through the industries of the country, do not consider that their sons have at present sufficient facilities for a higher education. They wish their sons to be graduates of a University and to retain a connection with it in after life ; nevertheless, it is only a few of them that are disposed to take advantage of the old English Universities. They probably feel that the social training at these Universities, with all its excellence, is hardly such as to fit the majority of its graduates for success in industrial occupations ; and, on the other hand, they know that their scientific training is very much below the mark. As a matter of fact, therefore, a number of men, forming a very important section of the community, do not avail themselves of these old institutions, nor will they be persuaded to do so. They want a more suitable kind of education for their sons. Such an education is furnished by the various provincial colleges which are rapidly springing up, and of which Owens College is the oldest and best known representative—but none of these institutions have the power of granting degrees.

We must therefore conclude that sufficient facilities are not afforded to the inhabitants of the north of England in respect of the higher education, and this is especially felt by comparison with the manufacturing districts of Scotland as represented by Glasgow, a city which is the seat of a well-known University with all the privileges of granting degrees.

As one means of overcoming this deficiency, affiliation with one of the older Universities has been suggested. Regarding this scheme it is only necessary to quote the words of the Owens College pamphlet embodying the views of the Senate, that "where a college has already attained to a life and a character of its own it is impossible to accommodate it to institutions of an altogether different historical growth."

There is yet, however, another alternative. Why, it may be said, should not the University of London be definitely and finally recognised as the degree-giving body for all the provincial colleges? The great objection to this arrangement is its inconsistency with the true theory of a University, and besides as a matter of fact it does not work well at the present moment.

[1] Continued from p. 226.

Before proceeding to prove this, let us make a few remarks upon the general system of examination. A great deal has been said and written against this system, as if examinations in themselves were rather to be avoided than otherwise. This, however, is surely a mistake. The University of London does not, in our opinion, err in respect of its examinations being excessive, but rather in respect of its examinations being incomplete. *A properly conducted examination system tests the power of the pupil for producing his knowledge when occasion requires.* If it be the case that the Jesuits excel in this art, so much the more credit to them, for the art of producing one's knowledge is something desirable, which ought certainly to be taught.

Now the fault we have to find with the University of London is that, at least in its junior examinations, it does not test the excellence of the manner in which a candidate produces his knowledge, and can hardly be expected to do so. The London examination is not led up to by previous class examinations, in which the knowledge-producing power of the various pupils is carefully tested and commented on. If the candidate passes in, let us say, the matriculation examination, he may get credit for the quantity of his knowledge, but none for the excellence of his method of producing it. If he fails to pass from want of this facility, nothing is said—he is simply told that his knowledge has proved insufficient. If his power of producing knowledge is to be rectified, it must be done at his college, and under the eye of his teacher, but if he has no college and no teacher, it will not be done at all. And yet the University of London, from its privilege of granting degrees, has very great power over the various provincial colleges, and not only tells them by means of its calendar what things they must teach, but also the manner in which these things are to be taught. True freedom of teaching is incompatible with this system, and unquestionably the teaching that would *pay best* in an institution absolutely bound to the University of London would be of a style prejudicial to all originality. Indeed it would be a mistake for such institutions to have at the head of their departments teachers of originality and power of research. Teaching of the kind to suit this system is incompatible with research.

But if the University of London be deficient in this respect, it is even more so in the other functions of a University. It can hardly be said to take any account of the moral, the social, or the physical training of its alumni. In fine it has the paramount power of granting degrees, but without any corresponding responsibility, for it leaves the most important parts of its graduate education to be done by other institutions, or even not to be done at all.

In this article we have endeavoured to show that an extension of the system of the present Universities is inadequate to the educational wants of the country. In a future article we shall discuss in what way these wants may, in our opinion, be most properly remedied.

THE DUTCH IN THE ARCTIC SEAS

The Dutch in the Arctic Seas. By Samuel Richard van Campen. Two vols. With Illustrations, Maps, and Appendix. Vol. I.—A Dutch Arctic Expedition and Route. (London: Trübner and Co., 1876.)

MR. VAN CAMPEN is a native of the United States, evidently of Dutch descent, and is enthusiastic on behalf of the past and future glory of his native country. The two volumes, of which the first has just been published, have been written for the express purpose of inducing the Hollanders to reassume their place in the field of Arctic exploration, which as a nation they have deserted since the last voyage of the famous Barents, now nearly 300 years ago. The prominent position which the Netherlanders once held as navigators and discoverers all the world over, is well known, and as seamen they still occupy as good a position as ever. Their addition to the list of, happily increasing, Arctic explorers would certainly be an acquisition; and we are glad to see that a movement has been commenced by the Dutch Society for the Promotion of Industry to induce the Government to enter into this matter in friendly rivalry and co-operation with other civilised countries. We hope the Society, backed by the arguments urged in Mr. van Campen's work, will be successful in their endeavours.

The work referred to—including the volume which is published and the one to come—is the expansion of two articles in the *Transatlantic Magazine.* The author endeavours to rouse the spirit of Hollanders by insisting on the glories which their nation achieved in the past, by pointing out how much yet remains to be done ere the Arctic problem be solved, by showing them what other nations are doing, and by pointing out that the Spitzbergen-Novaya-Zemlya route belongs to them by inheritance. Mr. van Campen rather boldly, but no doubt with considerable justice, compares the Dutch in the earlier days of their history to the Phœnicians, who in the pursuit of trade penetrated into the most distant parts of the earth, making many discoveries of which the record is lost. He brings our own country to the front as the "grand exemplar" in the matter of Arctic exploration, and shows that the motives which now actuate nations in the pursuit of this field of enterprise are nobler than those which led in the old days to the quest for a north-west or north-east passage. Mr. van Campen is strongly of opinion that the Dutch in these old days made many discoveries which have dropped out of sight, and that not improbably even the Franz-Josef Land of the Payer-Weyprecht Expedition was long ago discovered and some of its points named by the Dutch whalers who used to frequent these seas in great numbers. Dr. Petermann seems also to be of this opinion; and we are sure if the Dutch can make good their claim to any discoveries which have been renamed, everyone will rejoice to restore the old Dutch names.

Mr. van Campen urges many arguments in favour of Arctic Exploration, and especially in favour of its resumption by the Dutch. These arguments we need not recount here, as all our readers have been made familiar with them in connection with the expedition, which may by this time have found the secret of the Pole. The author devotes considerable space to a discussion, or rather a comparison of opinions, as to the nature of the unexplored region round the Pole. The map prefixed to this volume shows Dr. Petermann's continuation of Greenland right across to Kellet Land, somewhat N.W. from Behring Strait. We fear few geographers will agree with this conjectural Polar continent of Petermann; all that we know points to the likelihood of the undiscovered region being broken up into an archipelago. Mr. van Campen also devotes considerable space to the question of an open Polar

sea, a question which now seems to us out of date. We think, considering the object of his work, the author has made a mistake in filling up so much space with a comparison of opinions on these questions; he has done the same with the Gulf Stream and Ocean Current question, introducing large quotations from the well-known authors who have discussed it. We do not see that all this matter is quite relevant to the object for which the book has been published. The English readers, for whom the work must be meant, are already familiar with all that Mr. van Campen has brought forward, and so, we should think, are the Dutch readers who are likely to take an interest in the work. For both English and Dutch readers great compression would here have been advisable; and, indeed, we think the whole work might have been contained in one volume. All these conjectures as to the nature of the Polar region and the extent of the Gulf Stream seem to us waste of energy, as the only method of solution is to go and see. And this is what Mr. van Campen wants the Dutch to do. He also discusses the—to English readers, at least—somewhat threadbare question of routes, and with justice shows that the route for the Dutch is their old one by Spitzbergen or Novaya Zemlya. He thinks they might try either a route to the north-east by Novaya Zemlya somewhat on the traces of the Payer-Weyprecht expedition; or—and he seems to prefer this—they might make Spitzbergen a basis of operations, and with two ships establish a depôt, and by taking plenty of time, might in this way, partly by ship partly by sledge-boat, reach the Pole. Happily, however, Mr. van Campen does not hold up the Pole as the only and chief goal of Arctic exploration; he shows forcibly and fully the many great gains to science and humanity which are to be obtained by a perfectly equipped Arctic expedition. It would, we think, be fortunate both for the Dutch and for science if they could be persuaded again to occupy the field on which of old they reaped so much glory; and now that there is every likelihood of an international system of stations being established around the Polar regions, we cannot see that so important, though so small a nation, can any longer withhold itself from doing its share of the world's work in this matter. No doubt the Dutch have for long had much to do in looking after the affairs of their own household, but now there are signs that they have leisure and wealth enough to take a substantial part in cosmopolitan work. Mr. van Campen's arguments have already been brought under the notice of several prominent Dutchmen, and we think his object would be better served by the publication of a compressed Dutch edition, than it seems likely to be by this lecture read to the nation in the hearing of the English. "As certainly as the North Pole exists is it necessary to our command of the forces of nature, in the interests of mankind, that we should know in what way the ice and snow, the long nights and day, the tides and the geological formation of lands and islands about that mysterious summit of the Polar axis, react upon more favourable and fully inhabited climes. The *Alert* and *Discovery* have gone forth, then, at the call of England only, not to serve England only, but the entire world. And not less important, we may add, would prove a Dutch Arctic expedition for the service of science and mankind."

For English readers who want, in short space, to get a knowledge of the arguments in favour of Arctic exploration, of the discussion on the subject of the various routes, of an "open Polar sea," and the configuration of the unknown region, and on the question of ocean currents and the Gulf Stream, Mr. van Campen's first volume will prove useful. The second volume will, however, possess for us more of novelty and interest, as it will contain a history of Dutch Arctic enterprise. As there are no cuts in this volume, we presume Volume II. will be well supplied with illustrations and maps. We hope soon to have it before us.

OUR BOOK SHELF

Proceedings of the London Mathematical Society. Vol. VI. (London: Messrs. Hodgson, 1876.)

PROF. CAYLEY contributes to this volume several memoirs bearing on the theory of attraction. References to some of his earlier papers on the subject are given in Todhunter's "History." The titles of the present papers are "On the Potentials of Polygons and Polyhedra," "On the Potentials of the Ellipse and the Circle," "Determination of the Attraction of an Ellipsoidal Shell on an Exterior Point," "Note on a Point in the Theory of Attraction." The order of the papers will indicate the direction of growth the subject took in the author's hands. Mehler has treated of the attraction of polyhedra, but Prof. Cayley's results "are exhibited under forms which are very different from his, and which give rise to further developments of the theory." He finds general formulæ for the potentials of a cone and a shell, he then takes the case of a polyhedron or a polygon, obtains results for rectangular pyramid, rectangle, and cuboid, and verifies some of these results. The attraction of an indefinitely thin ellipsoidal shell was shown by Poisson to be in the direction of the axis of the circumscribed cone, this property was also demonstrated geometrically by Steiner. The geometrical investigation was subsequently completed by Prof. Adams so as to obtain from it the finite expression for the attraction of the shell, a result which had also been obtained analytically by Poisson. Prof. Cayley states the geometrical theorems, proves them, and obtains analytical expressions for the attraction of the shell and for the resolved attractions. The law of attraction throughout is that of the inverse square. The same writer also contributes a paper "On the Expression of the Co-ordinates of a Point of a Quartic Curve as Functions of a Parameter." This last is the development of a process of Prof. Sylvester's. Dr. Hirst's remarks on "Correlation in Space" are a mere abstract of results, a fuller statement of which is reserved for a future communication. Prof. Wolstenholme contributes a neat piece of analysis called "A New View of the Porism of the In- and circum-scribed Triangle." Prof. Sylvester contributes two interesting notes from M. Mannheim with reference to Peaucellier's cells and their application. The Rev. W. H. Laverty supplies an "Extension of Peaucellier's Theorem." Mr. Routh has a paper "On Laplace's Three Particles, with a Supplement on the Stability of Steady Motion;" Mr. Samuel Roberts contributes a paper "On a Simplified Method of obtaining the Order of Algebraical Conditions." This method is illustrated by various geometrical applications. Further papers of an analytical character are "On the Solution of Linear Differential Equations in Series," Mr. J. Hammond; "Note on some Relations between Certain Elliptic and Hyperbolic Functions," Mr. J. Griffiths; "Notes on Laplace's Coefficients," Mr. J. W. L. Glaisher. In mixed mathematics we have papers "On the Application of Hamilton's Characteristic Function to the Theory of an Optical Instrument symmetrical

about its Axis," and "On Hamilton's Characteristic Function for a Narrow Beam of Light," Prof. Clerk-Maxwell; "On the Vibrations of a Stretched Uniform Chain of Symmetrical Gyrostats," Sir W. Thomson. The President (Prof. H. J. Smith) contributes papers "On the Higher Singularities of Plane-curves" and "On the Integration of Discontinuous Functions;" Major J. R. Campbell gives an account of "The Diagonal Scale Principle applied to Angular Measurement in the Circular Slide Rule." Shorter papers are "On the Method of Reversion applied to the Transformation of Angles," Rev. C. Taylor (the basis of the communication of which an abstract only is given in the "Proceedings," the full paper being printed in the *Quarterly Journal of Mathematics*, No. 53, is a work on Conic Sections, by G. Walker, 1794); "On some Proposed Forms of Slide Rule," and "On the Mechanical Description of Equipotential Lines," Mr. G. H. Darwin; and "On the Mechanical Description of a Spheroconic" and "a Parallel Motion," by Mr. Hart.

From this enumeration of the contents of the volume before us, it will be seen that its contents range over nearly the whole domain of pure and applied mathematics.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

The Government "Vivisection" Bill

ALLOW me supply an omission in the paragraph in last week's NATURE which states that Mr. Cross "pointed out" to the deputation on this subject, "that the Bill was framed practically in accordance with the views of the Royal Commission." This astonishing assertion was of course contradicted at once, but the fact does not appear in the paragraph in question; and, though the discrepancy between the Royal Commission Report and the Government Bill is notorious and acknowledged on all sides, so few people read either the one or the other, that a statement to the contrary may be believed, if allowed to pass. Those who have given attention to the Blue-book in question know that while the evidence on which Legislation was recommended went beyond the facts, the Report beyond the evidence, and the recommendations beyond the Report, the Bill actually introduced by Lord Carnarvon did not so much exceed as contradict the recommendations of the Royal Commissioners. If a reasonable registration Bill in accordance with the Report of their own nominees had been framed by the Government, they would have spared themselves and others a good deal of trouble.

P. H. P. S.

The Boomerang

I OBSERVE a letter in NATURE (vol. xiii., p. 168) asking for information about the "boomerang." I have now taken the occasion of a number of the aboriginal natives of this district being here with me for a time, to make inquiries on the subject which might confirm or correct my own previous observations. The information I have gained as to the "boomerang" I now condense, preserving, however, as much as possible the language made use of by my informant. I have also seen the boomerang thrown by one of their best performers, a short account of which I will add in conclusion to this letter.

Two kinds of boomerang are made, one called "marndwullun wunkun," that is the "boomerang," as I may translate the term "wunkun," which turns round; "marndwullun" is equally applied to the returning flight of a bird as to a boomerang. The second kind of boomerang is called "tootgundy wunkun," that is the boomerang which goes straight on, "toot" meaning something "straight" or "erect."

The two boomerangs differ in their construction. The second (straight) kind being thicker, longer, and less curved than the first, I shall call, as a matter of convenience, the "marndwullun" No. 1, and the "tootgundy" No. 2.

With No. 1 there is no certainty of hitting the mark. It may come back too quickly, and may hit your own friends standing near you. In choosing a boomerang like No. 2, in preference, it will be more sure to hit the object, and will generally penetrate the mark with the point which has been held in the hand. A black fellow will prefer one of the kind No. 2, if required for fighting. That is, he can make more sure of hitting his enemy. With No. 1 he will probably miss or even injure his friends, as it is difficult to tell where it will come back to. If No. 1 strikes an object it will never return; besides, it is generally too light to do much execution. These statements, which I have recorded as nearly as possible as given to me to-day, quite confirm my own observations made during the last twenty years in Victoria, South Australia, New South Wales, the Queensland Back country, and Central Australia. In Cooper's Creek I have seen boomerangs No. 1 used by the natives to kill ducks and birds in general which fly in flocks. They seemed unable to calculate where its course would be among them, and some were hit; the boomerang and the bird both fell. I have often seen these weapons thrown but never saw one return after striking an object. If slightly touching an object in its course, such as the small limb of a tree, it might continue a curve to the ground, but no longer in the same plane as before, and the impetus would be destroyed. A third kind of boomerang is used in Central Australia, as far at least as near to the tropics about the 141st meridian (north of Sturts Desert), which I think is only used for fighting at close quarters. Speaking from memory this variety is probably about 4 or 5 feet in length and of very heavy wood. I have rarely seen them carried, but have found them concealed near to or lying in the huts of camps from which the natives had fled at my approach. Finally, I have great doubt whether any of the natives can tell beforehand whether a boomerang No. 1 will, when finished, be a good "marndwullun wunkun" or not; and it is not uncommon for an aborigine, if he finds his boomerang to return instead of going straight to its mark, to heat it in the ashes and straighten it, so that the blade lies in one plane.

It may perhaps be not uninteresting to your correspondent if I record an instance or two in which the boomerang has been used in the settlement of quarrels in this district.

I write as follows, using the first person, and as much in the words of my informant as is possible:—

"Once I had a quarrel with one of our Kurni (black fellows). I was angry and called him 'barrat-dun.'[1] He was very cross. I had word from a friend that Daly was going to fight me. I was obliged to go, or be called 'jeeragan' (coward). A number of Kurni who had quarrelled had to fight each other at the same time.

"Our friends decided we were to fight with boomerangs. Both of us had 'tootgundy wunkun.' 'Marndwullan wunkun' would be no use, it is too light, and you can't take sure aim. Our friends stood round to see which was best man, just as I have seen the 'lowan' (white men) do. Daly threw the first boomerang because I had called him 'barrat-dun.' We threw turn and turn about. You can see the boomerangs coming. I dodged them as well as I could or turned them off with the shield. They passed me like a wind. I had a shield. If you turn the boomerangs they slide off. If you stop them they either break your shield or carry it away. One 'wunkun' passed me and stuck three or four inches into a dargan tree (Box – one of the Eucalypts). When the 'wunkuns' were all thrown we went towards each other with the 'culluck;' he put down the 'bamarook' (shield against the boomerangs or spears) and took up the 'turnmung' (shield against culluck = club). We had each a 'culluck' and a 'turnmung.' We both hit and warded off as I have seen white men do with their big knives (sword). At last Billy the Bull, one of our friends, ran in and cried out, 'moondanna' (that will do, or enough). Then we stopped. We were then friends. Daly said to me, 'Why did you call me that name?' I said, 'I am sorry.' There was no more.

"A few years ago 'Barny' woke up in his camp in the night and saw 'Lamby' standing by his fire. He was frightened, and said, 'What do you want?' Lamby said, 'Only some fire.' But Barny thought he had been 'ngarrat bun' (made sick). Perhaps it was with the 'yertung,' the little leg-bone of the kangaroo. If you point that at a sleeping man and sing a song he will be sick. I don't know the song, I never heard it; it might be, perhaps, beginning, 'Yertung, yertung, goombart, goombart.'[2] If he could do this without being seen the Kurni believe

[1] Barrat = sickness or disease. The whole term implies having acquired a loathsome form of disease, for which the aborigines have to thank the whites.

[2] Goombart is the large leg-bone, and is ground down with a sharp point at each end and worn in a hole through the septum of the nose. It is believed to have magical powers.

the man would become sick and die. I have never seen it done[1]

"Soon after Barny died News went about that Lamby had killed him Then went about also 'Laywin a ngangata' (news of war) Word was sent by the dead man's relations to come and fight at some place It was near the mouth of the Nicholson River at the Lakes All the Kurni from Bairnsdale to the Snowy River came The women sate down, beat the 'possum rugs with their hands, and called the other side names for 'ngarrat bun a Kurni' (bewitching or making sick a black fellow) The two brothers of the 'poor fellow' (the term commonly used in speaking English for dead man) threw boomerangs and 'kunnin' (a straight stick pointed at each end and about 2 feet 6 inches to 3 feet in length) Lamby had a shield At last a 'kunnin' went through his right leg just above his knee He drew it out behind and threw it back. But he missed, it was too slippery with blood Then they wanted to throw spears at him, but some 'Kurni' men and women stood up before Lamby, and the fight stopped Then they were friends Lamby had two shields (turnmung), one in his hand and one on the ground before him to be ready '

The above narratives will, I think, throw some light on the use of the boomerang, and are characteristic of the customs of the aborigines, which it is much to be regretted are going to oblivion A careful record of these—in fact a faithful record of the customs, the beliefs, the systems of consanguinity of the Australian aborigines would throw much light on the probable early condition even of the now civilised races I have for some years treasured

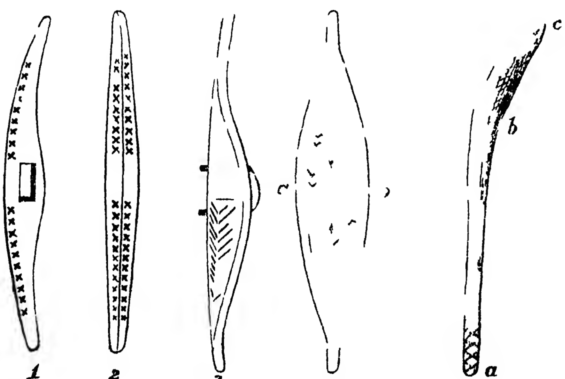


Fig. 1.—[illegible] view of [illegible] frequently of stringy bark [illegible] *Tur* [illegible] (*turnmung*) [illegible] handle [illegible] inch [illegible] end [illegible] inches

Fig. 2.—Front view of [illegible] turnmung

Fig. 3.—Side view of [illegible] made apparently of stringy bark wo[illegible] Height [illegible] width [illegible] ([illegible]) [illegible] inches The [illegible] convex surface is marked with angular or dotted incised patterns opposite quarters

Fig. 5.—Culluk drawn from memory *a* to *b* rounded handle [illegible] *b* to flattened [illegible] hatched [illegible] along the inside curv

up for future use everything I could gather on these subjects This mine of strange information is immense, and I regret to say not only unworked, but I fear destined to remain so—while the aborigines are rapidly fading away before the advancing wave of settlement To anyone who has not endeavoured to collect such information through others, the utter apathy which exists throughout the Australian colonies may seem inconceivable I regret to say that sad experience has shown me that it exists As an instance I may mention that of some 400 or 500 circulars which I have, together with my colleague in the inquiry, the Rev Mr Fison, sent out asking for information as to the systems of kinship obtaining, certainly not five per cent have produced replies, and scarcely more than one per cent yielded results.

This is, however, a digression, and I now give, as illustrating the two above narratives, slight sketches of the "bamarook," the "turnmung," and the "culluck

The boomerang throwing to which I have referred took place on the open flat lying between the River Mitchell and its branch known as the Backwater It was open and well suited for the purpose, but a sea-breeze was blowing There were present eight black fellows from different localities, extending from the Mitchell River to the Snowy River Among them was Lamby, the hero of the fight which I have narrated, Toolabar, a brother of the man Barny, and Long Harry, the acknowledged boomerang-thrower of the whole district, so much so that when I suggested that he should be called for the future "Bungil Wunkun," *i e*, "He of the Boomerang," the term was received with acclamation, and it is not improbable that for the future this may be his native name The only boomerang we had was one of the "marndwullun," or returning sort Throws were made by all, and the defects of the throws as well as of the instrument pointed out by one or the other almost in the same terms One arm of the boomerang was held to be too much curved for the instrument to return near the thrower. The throws proved this to be the case, as it was evidently impossible for the thrower or the spectators to tell exactly what the course of the missile would be in returning In some case it flew past over our heads and fell in the rear, at others flew in the opposite direction far to the front The explanation of this given me was that it was partly due to the uncertainty of the boomerang's return flight unless of rare perfection in make, and partly due to the wind which affected its course I found that the throws could be placed in two classes, one in which the boomerang was held when thrown in a plane perpendicular to the horizon, the other in which one plane of the boomerang was inclined to the left of the thrower

In the first method of throwing, the missile proceeded, revolving with great velocity, in a perpendicular plane for say 100 yards, when it became inclined to the left, travelling from right to left It then circled upwards, the plane in which it revolved in [illegible] a cone, the apex of which would lie some distance in front of the thrower. When the boomerang in travelling passed round to a point above and somewhat to the right of the thrower, and perhaps 100 feet above the ground, it appeared to become stationary for a moment, I can only use the term *hovering* to describe it It then commenced to descend, still revolving in the same direction, but the curve followed was reversed, the boomerang travelling from left to right, and the speed rapidly increasing, it flew into the rear At high speed a sharp whistling noise could be heard In the second method, which was shown by "bungil wunkun," and elicited admiring ejaculations of "ko ki" from the black fellows, the boomerang was thrown in a plane considerably inclined to the left It then flew forward for say the same distance as before, gradually curving upwards, when it seemed to "soar up—this is the best term—just as a bird may be seen to circle upwards with extended wings The boomerang of course was all this time revolving rapidly It is difficult to estimate the height to which it soared, making I think two gyrations, but judging from the height of neighbouring trees on the river bank, which it surmounted, it may have reached 150 feet It then soared round and round in a decreasing spiral and fell about 100 yards in front of the thrower This was performed several times The descending curve passed the thrower I think, three times Other throws were spoiled by the wind, which carried the boomerang far to the front I observed, and some of the aborigines confirmed it, that the thrower preferred throwing with the wind Another method of throwing was mentioned, namely, to throw the boomerang in such a manner that it would strike the ground with its flat side some distance in front of the thrower It would then rise upwards in a spiral, returning in the same. This was not attempted as it was decided the boomerang was not strong enough. A final throw in a vertical plane so that the missile struck the ground violently fifty or sixty yards in advance terminated the display It ricocheted three times with a twanging noise and split along the centre My black friends said they should soon manufacture a number of the best constructed "wunkun" to show me I observed that the spectators stood about a hundred yards on one side of the thrower, and when the boomerang in its gyrations approached us every blackfellow had his eyes sharply fixed on it The fact stated by them that it was dangerous was well shown in one instance, where it suddenly wheeled and flew so close over us that I and Toolabar fell over

[1] As an example I may give the snake charm which is sung to a monotonous chant. The blacks tell me they sing this and suck the wound for snake bite —

"Yane thay, gaylunga gaylunga
Yane thay, gaylunga gaylunga
Willel a wirreba, wirn biyow

repeated indefinitely It may be translated —

'Oh, the jaw of the gaylung, the gaylung
Oh the jaw of the gaylung the gaylung
Go and hide yourself in the bush in its nest

Gaylung is I believe, a Hoplocephalus and very deadly It is said to frequent the rats nests, which are made of grass

each other in dodging it. The expression used by them was "Marndwullun no good for fight; if he no hit 'em man, might come back and hit your friend beside you." I questioned the black fellows as to whether they thought a boomerang could be thrown so as to return to the hand of the thrower. Seven said "no," and characterised the statement as "jetbollan," *i.e.* a falsehood; the eighth said he once made a boomerang that when thrown on a calm day with great care would gyrate round and round until it descended to the ground not far from him, moving as slowly as a leaf falling from a tree, and that he once ran forward and nearly caught it. He said also "no Kurni (black fellow) can catch a wunkun when he flying—he would cut his hand open."

All the black fellows were unanimous in stating that a boomerang when it has struck anything ceases its course.

I have now stated all that at present suggests itself as to the boomerang. I fear that I may have trespassed too much on your space and on the patience of your readers.

Bairnsdale, Gippsland, Victoria, March 3 ALFRED W. HOWITT

Fertilisation of Flowers.—The Cuckoo

As a fact interesting in connection with the fertilisation of flowers, I have observed that in *Scabiosa arvensis* the stamens are elongated and the anthers ripened successively—not simultaneously—in each individual floret, the first having fallen off the filament, while the fourth is yet colourless and curled up in the tube of the corolla, the other two being in intermediate stages of development.

May I also state in reference to the Cuckoo, that a rhyme well known in Somersetshire, runs thus:—

"In April, come he will,
In May, he sings all day,
In June, he alters his tune,
In July, he prepares to fly,
In August, go he must."

By which it is clearly not meant that the Cuckoo ceases to sing in that part of the country at Midsummer. This break of note in June is generally to be noticed about the middle of the month. I, this year, heard it for the first time on the 28th May.

Ealing CHAS. FRED. WHITE

The Cuckoo

IN connection with the notes of Mr. Adair and Mr. Joyner in NATURE of July 6th and 13th, let me record that the Cuckoo has not even yet left us in the Midlands. I heard it only last evening near to my own house. There is a popular rhyme, long current in Derbyshire, concerning this bird. One couplet tells us the Cuckoo may be heard

"In April, May, June, and July,
If she sings any longer she'll tell a story;"

so that even this rude rhyme shows that it is not expected to depart earlier than this month. LLEWELLYNN JEWITT

Winster Hall, Derbyshire, July 15

ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE[1]

IV.

Experimentation for Determining the best means of Restoring Animation after some Forms of Accidental Death.

THE frequent occurrences of death from the administration of chloroform and other agents of the anæsthetic series led me very early to experiment for the purpose of discovering the best means of restoring life after such accidents. I commenced this research in 1851, and have continued it up to the present time. I consider it to have been one of the most fruitful in useful practical results. The details of the work have been communicated at various times to the world of science, and at considerable length. They formed the subject of a special report to the British Medical Association at its meeting in London in 1862. They formed the subject of a report to the Royal Society in 1865. They were continued in the Croonian Lecture delivered before the same Society in 1873, and they were introduced into various lectures on experimental and practical medicine, and into reports on the physiological action of organic chemical compounds made to the British Association for the Advancement of Science.

[1] Continued from p. 199.

As the account of these inquiries covers a great deal of ground and brings into light many curious and interesting topics, I shall devote a little extra time to the abstract of the experimentation.

Method of Experimental Research.

The mode of experiment in this research has consisted chiefly in testing the action of the narcotic vapours; the vapours of chloroform, ether, nitrous oxide, carbonic acid, choke damp, carbonic oxide, hydrocyanic acid, methylal, chloral hydrate, and others similar. Some inquiries have also been made relative to instant death by mechanical and electrical shocks, and to death by drowning and cold.

In every case the animal has been submitted as painlessly and rapidly as possible to the process which we call death. The rapidity and painlessness were essential to the experimental inquiry; because the more rapidly and the more placidly the animation is suspended, the less is the body exposed to the risk of organic injury.

In the course of observation two steps have been followed.

I.

In the first line of inquiry the animals have been allowed to die without any attempt to restore life, the object being to ascertain why death took place. After death the organs of the body have been examined in order to determine what was the action of the destroying agent on them. How did it arrest the living action?

The first question asked had relation to the condition of the lungs:—Were they left bloodless, containing some blood, or congested with blood? The second question had relation to the heart:—Were its cavities left full, or empty of blood; were they distended or collapsed; was the blood left in the cavities of natural or unnatural colour; were the muscular walls of the heart still excitable to motion, or were they quite inactive; if the muscular walls were inactive were they rendered inactive by rigidity of contraction or by relaxation? The third question had relation to the blood:—Had the blood undergone coagulation, and if it had not at the time when the examination was made, how long a time elapsed for the completion of the process? What was the condition of the blood corpuscles; were they scattered or massed together, were they perfect in outline or irregular? What was the colour of the blood on the two sides of the circulation; was the venous blood darker than the arterial, or were the two kinds of blood mixed in respect to colour? Were any gases escaping from the blood or had any escaped? Had the fibrine escaped from the other constituent parts? Had the blood accumulated in any of the vascular organs, or had it exuded from its vessels in whole or in part? The fourth question related to the state of the nervous organs, the brain and spinal cord:—Were these organs congested or free of congestion? Was there any effusion of blood or of serum into them? Was the appearance of the white and grey matter natural or morbid? Were the membranes vascular or pale? The sixth question had relation to the state of the visceral organs in the cavity of the abdomen:—Were the kidneys free of congestion, or were they congested? Was the colour of the intestines natural? Were the liver and spleen congested or free of congestion? The seventh question had regard to the muscular system:—How long a period elapsed before the muscles became spontaneously rigid? After what modes of death from the different agents did the muscles continue most active under the influence of the galvanic current? What sets of muscles first ceased to respond to the current, the muscles of respiration or the muscles of

locomotion? What other stimulants than galvanism would excite muscular movement after systemic death?

The above-named questions follow in series in relation to the condition of the animal body and its parts after death. In addition other observations were made to which it is necessary to refer.

The influence of the narcotics on the temperature of the body immediately before and after death was studied with much care. The variations of the animal temperatures under different degrees of natural atmospheric temperatures, from summer heat to extreme of winter cold, were noted. The different modifications of temperature that occurred in different organs of the body, brain, stomach, lungs, heart, liver, and abdominal cavity immediately after death were also observed.

The influence of the anæsthetic vapours on the minute or capillary circulation of the blood was determined by microscopical observation. In these experiments the web of the foot of the frog was made the field of observation. The animals were narcotised with the different vapours, and while narcotised the state of the circulation through the minute vessels, arterial and venous, was recorded during every stage of narcotism, and was compared with the state of the same parts that existed previous to the induction of the narcotic condition. The information sought for in this part of the inquiry related to the action of the narcotic vapour on the circulation of the blood corpuscles through the minute vessels; the changes of form in the corpuscles, red and white, if any changes occurred in them; the changes in the calibre of the vessels on the arterial and venous side; the point of arrest of the circulation through the vessels when the circulation finally stopped; the point of return of motion if the circulation were restored; and, the effect of various changes of external conditions such as warmth, cold, and moisture on the circulation during the stages of narcotic sleep.

One other important part of this line of inquiry was the determination of the conditions in which an animal body assumed to be dead could be best kept so as to retain those states of organs and parts which are favourable to the re-establishment of living motion. Should the body be left in a warm or a cold atmosphere? What circumstances determine the suspension of the process of coagulation of the blood and of cadaveric rigidity? Briefly stated these were the points of inquiry sought for under the first direction of research. By them I have been able to distinguish the conditions in which all the known anæsthetics leave the organs of the body when they kill.

II.

In the second line of inquiry the objects sought after were the rational means, suggested by the previous inquiries, for recalling animation after the signs of life have ceased. In this direction the following questions were asked:—

1. What is the precise value of *artificial respiration?* What is the most perfect method of carrying out artificial respiration? How long should the process of artificial respiration be continued, and what are the proofs that its continuance will be useless? When it has proved useful in restoring natural respiration, how long should it be continued? What dangers are connected with its employment?

2. Is it possible when the phenomena of suspended animation are present, to restore the circulation? By this process, to which I have given the name of *artificial circulation* (*British and Foreign Medico-Chirurgical Review*, April, 1863), I tried to restore the current of blood through the vessels, by transfusion of other blood; by mechanically pumping the blood within the veins of the dead body, over the lungs into the arterial circuit; by attempting to draw the blood over into the arterial circuit from the venous circuit; by altering the position of the body in alternate motion up and down.

3. Is it possible to combine artificial respiration with artificial circulation? In this endeavour I tried the combination of the two methods, and with the hope of being able to drive or draw a current of blood over the lungs while the blood remained fluid, and of being able also to aërate the blood in its passage by keeping up artificial respiration.

4. Is it possible to utilise the galvanic current so as to restore animation? In this inquiry the galvanic current was employed so as to call into play the action of the muscles of respiration: the heart: the voluntary muscles.

5. Can the heart, after it has stopped, be excited into motion by injecting into it agents which stimulate it to contraction? In this inquiry ammonia and other excitants were injected into the heart, while artificial respiration was maintained.

6. What is the value of external warmth in various degrees for restoring animation? In this research the effects of warm external applications, warm sand, moist warm air, dry warm air, moist warm straw, and other similar means were carefully tested.

In the briefest terms I have thus sketched out the mode of inquiry adopted in the course of experimentation now under notice. Fuller details are recorded in the paper published in 1863 in the *Medico-Chirurgical Review*, but these now given are sufficient for this abstract.

RESULTS.

The practical results which have followed on these researches are very numerous. I will write those which seem to be most practical and useful.

On Artificial Respiration.—In respect to artificial respiration the following facts were learned:—

If artificial respiration be sustained, even with an atmosphere of chloroform that is sufficiently narcotic to keep up deep narcotism, the action of the heart continues and recovery of life is possible. In brief, the mode of death from chloroform and perhaps from all the other narcotic vapours is actually due to the arrest of the current of blood through the minute vessels in the circuit of the lungs.

Artificial respiration, when perfectly carried out, was found sufficient to restore life after natural respiration had entirely ceased, and when all external evidence of motion of the heart had also ceased. To make this fact matter of direct application, I invented a double-acting elastic hand-bellows, which performed when in action the double purpose of emptying the lungs of their contained air by one movement, and of filling them with fresh atmospheric air by another movement. I also arranged the instrument in such manner, that on emptying the lungs of air a current of blood is mechanically drawn upwards from the right side of the heart, by which the oppression of the right side of the heart from tension is removed, and its muscular contraction is recalled into play. My latest instrument for this purpose is now so graduated, that measured quantities of air can be withdrawn and introduced, and the physico-chemical action of the lungs can be imitated with the greatest refinement, and with results that are different to any that have been gained before. Thus, after death from some of the narcotic vapours I have been able to restore life as long as eleven minutes after all the external signs of life have ceased. The results of the experiments proved also that when once the natural respiration is established the artificial ought to cease, so that the enfeebled circulation and respiration may return into play together. Further, the experimentation showed that artificial respiration, while it may be made, by delicate using, an all but certain means for the restoration of life after death from narcotic vapours, it may by bad use be made the certain means of ensuring death; that in performing it any rude movement of the body, or any violent inflation of the lung, or any attempt to inflate the lung while the lung is full of air, and the right side of the heart, full of blood, is sufficient to complete the process of destruction of balance and to cause unavoidable death. In a word, the experimentation

showed that as with a fire that is well-nigh burned out we can restore action by laying new fuel lightly on the remaining flame, and then by gentle blowing can communicate the flame to the new fuel, so in artificial respiration the same delicacy of procedure will reproduce the vital flame.

In the absence of experimentation these facts could never have been learned. It was necessary to see the effects of various methods under various conditions, and under various circumstances in order to arrive at certain conclusions. A century of observations on men subjected to accidents that destroy life would not have taught so much as was learned in a few hours from the observations on the inferior animals.

Artificial Circulation.—The inquiry on the subject of artificial circulation proved that the attempt to establish the circulation by injection into the vessels, or by forcing the blood over the lungs, or by drawing it over in combination with artificial respiration, failed by reason of the coagulation of blood which followed such attempts. Some countenance was given, by the experiments, to the attempt to encourage a current of circulation by the process of raising and depressing the body so as to place the head at one moment below the level and at another moment above the level of the body; but on the whole the effort to restore the circulation through the lungs was most expedient by the simple plan of artificial respiration carried out as above stated.

Use of Galvanism. The research instituted to test the value of galvanism as a means of restoring animation had a most important practical bearing. By regulating the intermittent current with a metronome I found it possible to make the respiratory muscles of an animal recently dead act in precise imitation of life. I also found that the heart could be excited into brisk contraction by the same means. But the result came out that by this method the muscles excited by the current dropped quickly into irrevocable death through becoming exhausted under the stimulus, and that in fact the galvanic battery, according to our present knowledge of its use in these cases, is an all but certain instrument of death. By subjecting animals to death from the vapour of chloroform in the same atmosphere, and treating one set by artificial respiration with the double-acting pump, and the other set by artificial respiration excited by galvanism, I found that the first would recover in the proportion of five out of six, the second in proportion of one out of six. Further, I found that if during the performance of mechanical artificial respiration the heart were excited by galvanism, death was all but invariable. The explanation of these experimental truths is illustrated by a simple simile. If an animal reduced in power to the last degree from want of food be carried to a place of succour, it may recover; but if it be stimulated or forced to walk to the place it will possibly die on the way. So with a man or animal under prostration from shock or narcotism; if the surgeon uses his own force for the restoration of the enfeebled muscles of the man before him he may restore the muscles to power; but if he uses up the last remaining force in the muscles of his patient by stimulation he will kill them outright. Considering that in the large number of instances of sudden death by accident, the first thing "tried" for restoring life is the galvanic battery, the information on the subject thus yielded by experiment, and which could have been got in no other way, is a result which, though unexpected, is none the less valuable. Indeed the peculiarity of experimental pursuit is that something unexpected in result is always learned, and is almost always useful.

Injection of Stimulants.—The effect of injecting ammonia, and other stimulants into the heart for the purpose of exciting the walls of the heart into contraction, was found to be as faulty as the application of galvanism for the same purpose. It produced a final contraction which was fatal.

Use of External Warmth.—The research on the action of warmth on animals under suspended animation was singularly interesting. I found that when an animal under a narcotic is still breathing, however faintly, the restoration of the animal warmth is often alone sufficient to restore life. This came out of the observation of the action of narcotics in reducing temperature, and in my first researches on chloral hydrate I showed that of two animals under the same lethal dose one was safe to recover in a warm air, while the other in a cold air would die. These facts relate to animals which are still breathing though all but dead.

On the other hand, I discovered that if an animal had actually ceased to breathe, the most certain way of ensuring its death is the exposure of it to heat; the most certain way of retaining it in a condition for possible recovery and of retaining its muscular irritability under stimulus is the exposure of it to cold. Heat I found excites the final muscular contraction and causes coagulation of the fibrine of the blood; cold suspends both. Thus in a warm-blooded animal exposed, after its death from chloroform, to extreme cold in a dry air, I found every muscle in the body that I could reach vigorously active under re-applied warmth and galvanism three hours after death; while in fish and batrachians I found it possible to restore life altogether after they had been accidentally inclosed, that is to say, frozen up in ice. As we arrive at clearer knowledge of the means of restoring animation in man, these facts will have a bearing of the extremest value. Already they indicate that in the death of the human subject by drowning and cold, attempts to restore life are demanded even hours after the occurrence of the accident.

Lastly, on this head, the experimentation taught me that while in the process of resuscitation it is very bad practice to immerse the body in a heated medium like hot water, it is of the utmost importance to establish the artificial respiration with a warm and dry air. Such an air prevents condensation of water in the bronchial tubes, quickens the process of oxidation of blood, and allows the body to become warm from its own natural centres of vital heat.

PRACTICAL APPLICATIONS.

The experimental inquiry herewith briefly stated is too new to have brought forth much fruit. The grand practical results for which it was pursued have to follow in course of years. Some results have, however, already been realised.

Immediately after chloral hydrate came into use, the dangers from its use were found to be imminent. I was able to point out even before such dangers had occurred that the cause of danger was reduction of animal temperature from the agent, and that in treating a person poisoned with chloral two things were required, viz., to maintain a high atmospheric temperature, and to give warm food. Twice I have been summoned to these accidental poisonings, and in both instances I have saved life by these simple and purely scientific modes of cure. Probably after a number of deaths of men from chloral, it might have been learned that the cause of death was the reduction of animal heat. The fact gained instantly by observation on the lower animals supplied the knowledge in advance of the accident.

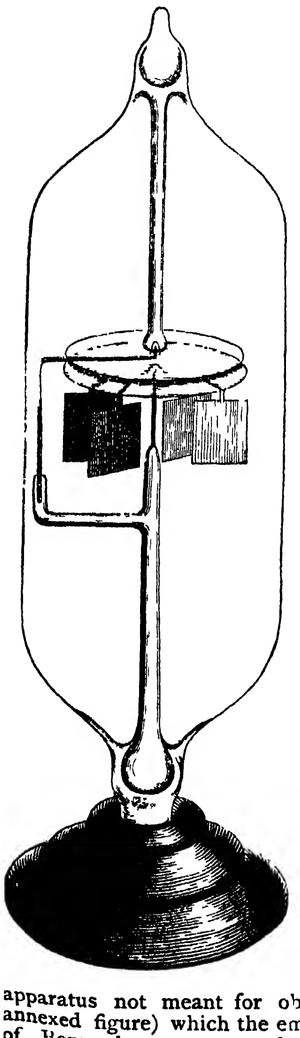
In two instances in the human subject in which after the performance of the operation of tracheotomy, life has become suspended from obstruction to the entrance of air into the lungs below the artificial opening, the obstruction has been removed, and afterwards by means of artificial respiration carried out with the instrument I have described above, life has been restored after all the ordinary evidences of death were manifested. In one of these examples of restored life the recovery was complete and the patient is now as well as ever he was. But for the long period of eleven minutes he lay in all the character of death, depending solely for returning life on the surgeon who supplemented his respiratory power and who gently fanned back into life a flame which had ceased for ever if scientific experimentation on the lower animals had not shown the possibility of its return by the hand of science.

(*To be continued*)

SCIENCE IN GERMANY

(*From a German Correspondent*)

It is known to have been first discovered theoretically by Maxwell, that the co-efficient of friction of a gas is independent of the pressure. This law has been tested and confirmed by Maxwell and O. E. Meyer, and more recently by Kundt and Warburg (*Philosophical Magazine*, 4, vol. iv.; and fully in *Poggendorff's Annalen*, Bd. 155 and 156) with reference to the sliding of gases in limits between 760 and 1 mm. pressure of mercury. The latter experimenters observed, as Maxwell did, the decrease of vibrations of a round glass disc suspended bifilarly between two fixed plates. At pressures under 1 mm. Kundt and Warburg were unable accurately to investigate the friction. They could perceive, however, that with continued progressive evacuation by the friction apparatus, the damping force exerted by the rarefied gas on the motion of the oscillating disc, decreases; still, even in the best vacuum which could be produced, it had still a considerable value. Thus, *e.g.*, in the best hydrogen vacuum which Kundt and Warburg could produce, the damping force was not less than one-third of the value obtained with full hydrogen-pressure (760 mm. mercury).



To demonstrate the friction in such a vacuum before a large audience, Prof. Kundt recently constructed an apparatus, which he employed when giving a lecture on the gas theory before a scientific society in Berlin in March last. The essential part of the apparatus consists of two small discs of mica, suspended one over the other in an evacuated space. When the under disc, which, like Crookes's radiometer, is furnished with four light vanes blackened on one side, is set in rotation by the action of light, the upper disc begins to rotate in the same direction (though much more slowly) in consequence of the friction of some traces of air still present in the apparatus. (The upper disc of course nowhere touches the lower.) The description of this apparatus with drawings, will shortly appear in *Poggendorff's Annalen*. Here we content ourselves with the representation of a smaller apparatus not meant for objective demonstration (see annexed figure) which the eminent glass-artist, Geissler, of Bonn, has constructed at the instance of Prof. Kundt. This apparatus, like the ordinary radiometer, is entirely inclosed in glass. On a fine steel point rests, by means of a cap, the lower mica disc, with the radiometer cross fixed to it. The upper disc rests likewise on a fine steel point. This point is fixed to an arm which reaches over the lower disc, but without being in contact with it. On the upper disc a small mark is made (not shown in the figure), which enables one to perceive whether the disc rotates or not. Illuminated by the sun or candles, the radiometer cross with the mica disc fastened to it, enters into quick rotation, and the upper disc begins gradually to rotate in the same direction as the lower one.

S. W.

ON MODES OF DEMONSTRATING THE ACTION OF THE MEMBRANA TYMPANI

The movements of the bones of the tympanum in connection with sound-waves were first observed and their excursions measured by Buck ("Archiv. of Ophthalmology and Otology," vol. i., 1870), and more recently by Dr. Charles H. Burnett of Philadelphia, as recorded in the same Journal for 1872. The method followed in these researches was to expose the bones and membrane by chiselling away a portion of the wall of the tympanum, sprinkling on the chain of ossicles a little powdered amylum, so as to secure bright vibrating points, throwing light into the cavity by means of a condenser, and observing, with a microscope of low power, the excursions of the vibrating points when sound was conducted into the external ear. Various interesting deductions were drawn from these experiments as regards the amplitude of the excursions of vibrating points on different portions of the conducting mechanism, and as to the effect of variations of the fluid pressure within the labyrinth on the extent of movement. In the last number of the same journal an interesting paper appears from Dr. Clarence J. Blake of Boston on "the use of the Membrana Tympani as a Phonautograph and Logograph," accompanied by a plate. Dr. Blake's method consists of exposing the membrane and chain of bones, and fixing a light style (made "by splitting long wheat straw, scraping the inner cortical substance away, and separating single fibres") to the membrane. This style is caused to record its movements on a plate of smoked glass which is "carried smoothly and at a uniform speed in a direction at a right angle to the direction of the excursion of the style." . . . "The membrana tympani being set in vibration, and the carriage [bearing the smoked glass] drawn by its weight, moving at right angles to the excursions of the style, a wave-line, corresponding to the character and pitch of the musical tone sounded into the ear, is traced on the smoked glass."

There is still a third method which I have recently devised, chiefly for class illustration. It consists in converting the tympanic cavity into a manometric capsule, according to the method of Dr. Kœnig (*Philosophical Magazine*, 1873, vol. xlv. pp. 1-18, 105-114), and of viewing the oscillations caused by sound in a revolving mirror. A preparation is easily made from the ear of the cat. After sawing out the temporal bone, clearing away all loose tissue, and exposing the tympanic bulla, I make two small holes in the latter by means of a fine trephine. Into these holes two glass tubes, of corresponding diameter, are cemented with sealing wax—the one for leading gas into the tympanic cavity, and the other out of it. The preparation (which may be preserved in a moist state in a well-stoppered jar for a long period, and be used over and over again) is firmly fixed in a vice, one tube is connected with the gas supply, and the other with one of Kœnig's small burners. By means of a third tube inserted into the external auditory meatus, sound-waves are conducted to the membrane of the drum, the mirror is rotated, and the usual pictures corresponding to the pitch and quality of the sound are seen with exquisite delicacy. I have found tones of medium pitch (ut 3 to sol 4) produce the most distinct effects, and the vowels, if uttered with sufficient intensity, produce pictures which are quite characteristic. By using a preparation in which the auditory apparatus on each side is present, it is easy to devise an arrangement for showing the effects of

interference, in a manner similar to Kœnig's well-known apparatus for that purpose, constructed on the method of Wheatstone.

JOHN G. MCKENDRICK

THE GEOLOGICAL SURVEY OF NEWFOUNDLAND

DUE no ice of the Report for 1874, of Mr. Murray, the Director of the Newfoundland Geological Survey, has been delayed until the appearance of the map and sections referred to in that Report. These we have now received, and as they deserve more than ordinary attention from geologists, we propose to give some account of the recent work of the Survey. The able and indefatigable Director, who, like his late chief, Sir William Logan, has grown grey in the service of the Dominion, divides his Report into two parts, one of which narrates his own labours during 1874, while the other is furnished by his assistant, Mr. J. P. Howley, of whose surveys for the same period it gives the main results. Mr. Murray's Report is marked by that quiet practical good sense which formed so characteristic a feature of his contributions to the Canadian Geological Survey. It is more occupied with plans and advice for opening up the country to settlers, and developing the great resources of the island in timber and as a cattle-grazing district, than with geological matters. The latter are treated, too, with an eye to future mineral industries. Mr. Murray, in short, is doing the solid and useful work of pioneering. That work may make no brilliant display at the time, but if, as he hopefully anticipates, there is a prosperous future before Newfoundland, the colonists will look back upon his labours as those which largely guided and stimulated that prosperity.

But Mr. Murray is too true a geologist to let any chance escape him of advancing the purely scientific treatment of geology. And he is fortunate in possessing in Mr. Howley a geologist who can carry out his views with admirable skill. From Mr. Howley's Report and Map geologists in other countries will learn some particulars not only important as regards the geology of the colony, but of general interest as bearing on the question of the nature and *modus operandi* of the metamorphic action to which the origin of such rocks as dolomite and serpentine is attributed.

Mr. Howley's labours during 1874 were, in accordance with Mr. Murray's plans, given to the survey, topographical and geological, of the western coast of Newfoundland, about the peninsula and bays of Port-a-Port, and St. George's Bay. In tracing the Lower Silurian formations of the Newfoundland coast, Mr. Murray and his colleagues have been able to identify them with more or less precision as equivalents of the Quebec and Birdseye and Black River groups of Canada. But in the course of their surveys they have at different times encountered intercalated sheets of metamorphic rocks in the Lower Silurian series overlying unaltered and fossiliferous strata. Thus at Bonne Bay, in 1862, Mr. Richardson found highly metamorphosed rocks, including white talcose slates and serpentine, in some portion apparently of the Quebec group. Four years afterwards Mr. Murray observed further south, in the Bay of Islands, that sandstones believed to represent the Sillery zone of the Quebec group passed below the serpentine of the Blowmedown mountains. Mr. Howley has now confirmed and extended these observations by mapping the country between the Bay of Islands and St. George's Bay. He has traced Mr. Murray's serpentine rocks southwards to Bluff Head, and finds that they pass unconformably over different horizons of rocks which are taken to represent the Sillery and Levis subdivisions of the Quebec group of the Lower Silurian system. The striking character of this unconformable junction is well brought out upon the map, where two large cakes of the overlying rocks are seen to sweep over both anticlinal and synclinal folds of the lower formations. These cakes consist of brecciated dolomite or limestone, chlorite-slate, diorite, and serpentine, having a total thickness of perhaps 1,500 feet. Their exact geological horizon seems not yet quite satisfactorily fixed, but they are placed provisionally between the Sillery and Birdseye and Black River formations. Doubtless further details will be given in future reports regarding this remarkable feature of Newfoundland geology, and till they appear it may be well to avoid any discussion of the theoretical aspect of the subject. It is not the first time that an instance has occurred of the higher rocks of a district being more metamorphosed than the lower, but there has probably never been observed so remarkable a case, for here the metamorphosed and contorted series is described as actually overlying unmetamorphosed strata.

Other questions of interest occur in the Report. Thus, a centre of pre-carboniferous volcanic action is indicated as existing along a line north of Fox Island and on the coast to the south head of the Bay of Islands. The coal-measures, of which a few patches occur in the district surveyed, overlap from the Millstone Grit on to the Carboniferous Limestone. The latter formation contains, according to Mr. Davidson, brachiopoda which all belong to well-known British species. In another respect there is a curious analogy between the base of the Carboniferous system in Newfoundland and in some parts of Britain. In the former country the lower members of that system consist largely of red and green sandstones, clays, and conglomerates, with traces of plants, beds of gypsum, and occasional limestones full of ordinary Carboniferous Limestone fossils. Anyone who has looked at the base of the Carboniferous system in Cumberland, Westmoreland, Dumfriesshire, and other parts of Britain, will recognise these lithological features as characteristic also in this country. It would seem that the same physical conditions preceded the deposition of the Carboniferous Limestone on both sides of the Atlantic inland seas or lakes, not far separated from the sea, in which red sediment with gypsum and occasionally common salt was laid down, but which were not usually well suited for the support of molluscan life, though liable now and then to inroads of the sea outside and to invasions of mollusca, corals, and other marine forms.

The map, on a scale of four miles to an inch, is evidently a piece of most careful work. It shows the arrangement of the rocks from the Laurentian group up to the Coal-measures, though, partly from vast unconformabilities and partly from faults, great portions of the geological series are not represented in this part of Newfoundland. It may be mentioned, in passing, that the largest fault traced on the map- that which flanks the Laurentian range from Table Mountain north-eastwards to Grand Pond—is not coincident with the line of any river, but is crossed by all the chief rivers and brooks in the district which it traverses. Hence the same relation between fracture and erosion exists there which has been so extensively traced and keenly discussed in this country. To the completion of this important map geologists will look forward with not less interest than must be taken by those who see in the labours of Mr. Murray and his associates one of the best pledges for the early development of the colony.

A. G.

THE ANCIENT BRITISH PIG

PROF. ROLLESTON has recently been making some researches on swine, the discovery of some remains buried in the alluvium, near Oxford, having directed his attention to the subject. In illustration of a paper "On the Prehistoric British *Sus*," read by him at the Linnean Society, June 15, the following specimens were exhibited :—1. Skull of *Sus scrofa*, var. *domesticus*, from a late Celtic interment. 2. Skulls of *Sus scrofa*, var. *ferus*, from

alluvium near Oxford, and from Germany 3. Skull of *Sus andamanensis*, forwarded him by J Wood Mason. 4 Skull of *Sus cristatus*, lent by Sir Walter Elliott, K.C.S.T. 5. Skull of *Sus barbatus* wrongly named *S. verrucosus*, and needlessly *Euhys barbatus* in some mammalogical catalogues.

From these and other data the author bases the subjoined conclusions:—

1 The domesticated pig of Pre-Roman times, as exemplified at least by the specimens from the interment referred to, appear to resemble *Sus scrofa*, var. *ferus*, rather than *S cristatus*, or the domestic variety, *S indicus*

2 On the other hand, *S cristatus*, the Indian wild hog, appears to him, whilst being readily and always distinguishable from *S scrofa*, var *ferus*, to differ from it, mainly by the retention permanently of certain structural conformations which were only temporarily represented in the European wild species The third molars of the male, *S cristatus*, varied, however, concomitantly with its canines, and showed a much larger development of their posterior lobe, than either *S scrofa*, var *ferus*, or the females of their own species The rearmost lobe, however, of the posterior molar, varies a good deal in *S scrofa*, var. *ferus*, irrespective of sex

3 Bearing in mind the elasticity of the swine type and the power for changing which their domestication has shown to possess, Dr Rolleston has less difficulty in conceiving that the so-called *S indicus* was really a modified *S cristatus*, than that it had been evolved from any *Sus*, such as *S leucomystax*, from countries further away from Europe than India *S cristatus* had the malar border of the lachrymal always marked by the relative shortness insisted on by Nathusius It had not the relatively wider palate, but upon this point too much weight had been laid.

4 A skull of a wild sow, from the alluvium, later in date than the "river gravels," near Oxford, combined the short lachrymal characteristic of young pigs and of *S. cristatus*, with the worn down teeth, elongated facial skeleton, and disproportionally small size of an old wild sow, *S scrofa*, var *ferus* Such a combination of characteristics tended to suggest carefulness as to accepting the Torf Schwein *S scrofa*, var *palustris*, of Rutimeyer, as a distinct species, or taking even such a point as the shortness of the lachrymal as constituting a specific difference

5 The simplicity of the third molars in the very large skull of *S barbatus* appear to be of greater value, as the rugose condition might have been expected to be forthcoming in so large, so well armed, and so well fed a *Sus* as this from Borneo

6 The true *S verrucosus* differs from *S barbatus* in having the lachrymal's malar edges long, relatively to its orbital, as well as in the peculiarities which its specific name implies. These peculiarities were reproduced in the old Irish "Greyhound Pig" figured by Richardson "Domestic Pigs," p 49, Ed. Waine

7 The often-quoted paper by Dr Gordon, *Medical Times and Gazette*, May 2, 1857, p 429, led us to suppose that *Taenia solium* of man, infested the domestic pig of India, as it does those of other parts of the world The facility with which the pig lends itself to domestication enables us to understand how the many-sided commensalism which now exists between man and that animal may have set up in very early times. Indeed the particular results of their commensalism which their solidarity, as regards the alterations of the generations of *Taenia solium* represents, suggests that their co-existence in time must have been more extensive than even the co-existence in space ascribed to them, not quite correctly, by Gibbon ("Decline and Fall," chap. ix. note 9, p 392, Smith's edition)

PHOTOGRAPHIC PROCESSES[1]

II.

WE next pass on to other applications of the dichromates for the production of prints, and the first I shall demonstrate is that known as carbon printing, but which is perhaps more correctly termed the autotype process It is dependent on the oxidation of gelatine, one of the substances which you may have already guessed would be capable of being acted upon by the dichromates If, then, we have a film of this gelatine impregnated with potassium dichromate, and after drying it be exposed to light, it will be found that all the portions acted upon will become insoluble in hot water; that is, supposing the duration of the exposure be of sufficient duration, and if the light be sufficiently intense. Imagine now that beneath a negative of delicate gradations of light and shade we place a film of sensitive gelatine, supported for convenience sake on paper, and allow sunlight to act upon it. After a time, in what condition will the gelatine be? It will be partially insoluble, more particularly on the surface next the negative, and the lights and shades will be represented by different depths of insoluble matter, according to the intensity of light penetrating through the various parts of the negative. I must here pause, and try and explain why this is At first sight it might seem that the *whole of the thickness of the film* ought to possess different ratios of solubility This is not true, however, the solubility is affected to different depths That coloured component of white light which is principally effective in producing the chemical change is blue, and which consequently finds a difficulty in piercing through the orange-coloured dichromate The amplitude or height of the blue wave is continually diminished, till finally it is almost extinguished. Now the intenser the white light the greater will be the original amplitude of this wave, and it is at once apparent that the limit of amplitude, which is effective to cause the chemical change, will be reached at a greater depth by those rays of light which were originally the brightest. A little reflection, then, will show you that the soluble part of the gelatine will principally be next the paper, and on immersion in hot water the viscous unaltered gelatine would remain imbedded between it and the outer insoluble surface Though several ingenious methods have been tried to render the support on which the gelatine rested sufficiently porous to allow the occluded parts to be washed away, yet, so far, no attempt has been completely successful To get over the difficulty the principle has been adopted of transferring the gelatine film to a temporary support, the outside surface being caused to adhere to it Evidently, by this means, the soluble gelatine can be washed away when the paper is peeled off, and a raised image insoluble in water would remain, which eventually may be transferred to its final support The temporary supports, usually employed are metal plates, glass, paper coated with an insoluble compound, &c A picture in gelatine alone, however, would be, comparatively speaking, of little value, as it is almost colourless, but if pigments be mixed with it the objection disappears. In the autotype process the gelatine is mixed with colouring matter and a coating is given to a piece of paper When dried the gelatine can be rendered sensitive by floating its surface on a solution of potassium dichromate, and after again drying is ready for printing Such a piece of prepared paper, or carbon tissue as it is technically called, we have here It has already been exposed beneath a negative, but no trace of any image is apparent, as the dark colour of the pigment masks it entirely In order to judge of the amount of light received during exposure resort then is had to what are called actinometers. The details of the instruments I will not enter into, suffice it to say it is usual to judge the depth of printing by the colour given to silver chloride Placing then the exposed tissue, gelatine side downwards, beneath water in which a zinc plate has already been immersed, and bringing the surfaces of the two together, they are withdrawn from the water with a film of moisture between You will notice that I left the print in the dish but a very short time, for a reason which you will presently understand By passing this "squeegee" (which is a bar of wood from which a thick strip of india rubber projects) over the back of the paper I drive out all the water from between the surfaces, and you see how the gelatine film clings to the zinc And why is this? You will find that it is not naturally adhesive, the light has changed the quality of the gelatine in this respect, then why does it hold so tight to the metal plate? Simply owing to the moisture left in the paper, the soluble gelatine soaks it up and expands. It cannot well expand laterally, so it expands upwards, and a partial vacuum is created between the gelatine and the plate. Now you see why I left the print in the water such a short time Had I left it in longer the total expansion would have taken place, and the necessary vacuum could not have been created when it was pressed on to the zinc plate

Now that it is firmly held, I can place it in hot water and remove the paper. It easily peels off, and the solvent action of the fluid can have fair play As I move it up and down in the trough, you can see the gelatine running over the surface. After a few minutes it is clean, and the development is finished On this plate I have another print which has already undergone similar treatment, but has been allowed to dry. This piece of

[1] Lecture by Capt Abney, R E, F R S, at the Loan Collection, South Kensington Continued from p 241.

transfer-paper is now heated in very hot water, and applied to the surface. It is "squeegeed" on to it, and you see it adheres, this time, however, by its "stickiness." Here is another print in the same stage, but the adhering paper is dry. Raising one corner of it by my nail, I can grasp it in my fingers, and the finished print strips off the plate held in position by the paper.

Such are the usual manipulations in autotype printing, and the pictures produced by this method should be permanent, and they must be as permanent as leather, or as the pigment which is employed to give visibility to the gelatine image. As I mentioned before, there are various modifications of the process; for instance, one is to develop the picture on the permanent support destined to bear it, using this instead of the zinc plate. A little consideration will show you that in this case the negative employed must be reversed.

We now come to a large class of printing processes known as photo-mechanical. And here I should state that the term photo-mechanical is applied to such processes as are independent of light for production of prints after that agency has once furnished a plate or means of producing a plate. The first of these that I shall attempt to describe is that known as the Woodbury type after the inventor, Mr. Walter Woodbury. The following outline will give some idea of the methods resorted to:—

A skin of gelatine is prepared somewhat in a similar manner to that which I shall describe in the heliotype process, only for this it receives a tough film of collodion on one surface. This surface is placed next a negative on glass, and the light from an unclouded sun or from a luminous point (such as the electric light) is allowed to fall on it. Owing to the thickness of the gelatine employed, this method of exposure is necessary in order to secure sharpness. The print is developed as in the autotype process, and we get an image in great relief, formed by the insoluble gelatine, resting on the tough collodion film. When dried, this relief picture is placed on the surface of a flat, soft metal plate, and, by hydraulic pressure, is forced into it, furnishing a mould, perfect in all its parts. The wonder is at first excited that the gelatine does not break under the enormous weight brought to bear upon it, but when it is recollected that ferns and grasses can be made to furnish similar impressions, the astonishment is diminished, in that the substance employed is now in a leathery condition.

Apparently it matters little as to which side of the relief is pressed into the plate. In one case we should have to use a reversed negative, whilst in the other any ordinary negative may be employed. This is important to the photographer, as may be surmised.

Before us we have the negative, a relief from it, and a mould taken from the relief. This mould is now placed in this press, which consists of a flat plate (which can give slightly in any direction, and is capable of being raised or lowered) and a flat hinged top, to which is affixed a perfect plane of glass. When this lid is brought down on to the mould, the lower lid gives till perfect contact is got between the two surfaces; a species of clamp enables the lid to be kept in position. You see on placing this piece of paper in the mould, the clamp closes with difficulty, but a little mechanical contrivance attached to it causes a great pressure to be brought to bear. Opening the press once more, a little warm gelatine, which has been impregnated with colour, is poured on the mould, and a piece of resinised paper placed over it; the press is again closed. The mass of cold metal soon cools the gelatine, and on opening the lid, it is found that the excess of gelatine has been squeezed out beyond the mould, and on lifting off the paper, a picture is found adhering to it. This image is really formed in precisely the same way that a cook forms her jelly in a mould, though the colouring matter in this case is somewhat different. When dry, the picture is rendered insoluble in water by passing it through an alum bath. At first sight, this process might seem to be slow, but when it is remembered that half a dozen moulds can be made from the same relief, it requires no great exercise of the imagination to surmise that the pictures may be produced almost as rapidly as a lithograph. I referred to the relief necessary to produce the mould. From what I have described it will be seen that the dried relief must be as great as the *wet print* of the autotype process in order to produce the same gradations.

The last process I shall describe is known as the heliotype process, and I have chosen it for demonstration as I am practically acquainted with its working at Chatham, and not from any inherent superiority it may possess. It is a type of all the photo-mechanical processes, if we except Woodbury-type, and it is to such as these that we must look for our book illustrations, though I am still in hopes that we may have a really good process for surface printing from a metal block, capable of being set up with type. We have a promising example of this latter process in what is known as Dallastint, the offspring of Mr. Duncan Dallas; but as it is a secret process I cannot say anything regarding its production.

In the heliotype process there are various operations.

To begin with, there is the preparation of the gelatine film on which the image is printed.

The manner of preparing it is as follows:—Gelatine is dissolved in water by aid of heat, and to it is added a sensitiser which consists of potassium dichromate, to which a small quantity of chrome alum is added. Now here I must remark that this chrome alum forms an important part of the process. Gelatine we know ordinarily dissolves in hot water, but if it be impregnated with chrome alum not only does it render the gelatine insoluble, but it also toughens it in a marked manner when it is wetted. When the subsequent operations are explained, the importance of this property bestowed on the gelatine will be manifest. The solution of gelatine (with this sensitiser mixed in it) is flowed over a carefully levelled glass plate to such a depth that in drying it has the thickness of a piece of Bristol board. The glass plate may be ground and very slightly waxed, or it may be coated with a dilute solution of india-rubber to facilitate the gelatine leaving it, when it is required to be employed for printing purposes. A negative (which must be what is known as a reversed negative) is placed in a pressure frame, the gelatine is stripped off the plate, and the surface, which was next the glass, is in contact with the taken image. The necessary exposure may be estimated by an actinometer or by examining the image in the printing frame. When judged to be sufficiently printed, the back of the print is hardened by exposure to light. This operation gives toughness to the gelatine and renders it capable of resisting the treatment it has subsequently to undergo.

The skin of gelatine is next taken, and immersed for a few seconds in cool water (in practice a temperature of over 60° F. is found to be the best). A pewter or other metal plate, coated with india-rubber is now placed underneath it, and the film caused to adhere to it by the use of the squeegee. The pressure of the atmosphere causes the adhesion as it does in the autotype process. For convenience sake the edges are now run round with a solution of india-rubber in benzole and paper pasted round them, to prevent the water getting beneath the skin. The plate is then immersed in cold water for about half-an-hour, to soak out the unaltered dichromate, and it is ready for use as a printing surface after the superfluous water is blotted off.

The gelatine skin is all in an insoluble state owing to the presence of the chrome alum; but further, the part where the light has acted fully will not absorb water, whilst that which only partially absorbs water has only been partially acted on by light, and the part wholly unacted upon absorbs it greedily. When a roller containing greasy ink is passed over it, those parts which contain a great deal of water take no ink, particularly if it be stiff ink. The parts containing a little water take the ink lightly, whilst those parts which have refused to imbibe any moisture take it greedily. Evidently here we have a means of obtaining a picture of half-tone subjects in printers' ink. Another point is that thin ink takes better in a partially exposed portion than does a thick ink, hence to bring out the half-tone it is customary to use two or even three inks of different consistency. The printing plate is generally placed in the bed of an ordinary printing press and rolled up with a soft roller or rollers, charged with the printing inks. The impressions are pulled off as for letter press, though more force is necessary. In order to have clean margins a mask is cut of the proper dimensions, and brought to certain register marks. The paper, usually employed for receiving the impressions, is enamelled, the enamel being formed of barium sulphate and gelatine. Any ordinary paper, however, may be used, if it have the power of taking up the ink. On the walls of the exhibition are some photographs printed on ordinary drawing paper, and they are effective in their way.

Mr. Edwards, the patentee of this process, proposed to use a series of gelatine printing surfaces from the same negative, to form a species of photo-chromotype, and I have seen some specimens which are very successful. Little seems to have been done, however, in this direction at present. When drawing your attention to the manufacture of the gelatine skins there was one point to which I did not allude. You may make your skin of jelly or of blanc mange. I have found that a certain proportion of milk added to the gelatine in lieu of the water gives more delicate pictures than does gelatine

alone. There are several kindred processes worked at present, amongst which I must notice that of the Autotype Company. In their process an exceedingly thin layer of gelatine is formed on the plate and hardened by means of gum resins. The gelatine is not removed from the plate, but it is printed from whilst still on it. The film is hardened from the back. The glass plate can be inked in as described for the heliotype process, and can be pulled in a lithographic press or in an ordinary printing-press. M. Thiel, of whose process we have beautiful examples on the walls of this room, uses an ordinary lithographic printing-press.

I have only been enabled to give you a brief outline of these few processes, specimens of all of which are to be found in this exhibition. Short as have been the descriptions, I hope, however, that they have been sufficient to enable you to see the immense strides in the methods of producing prints that have been made in the last dozen years. When we consider that the autotype, the Woodbury type, and all the other mechanical printing processes have been worked out in that time, you will see that the inventive faculties of those who labour in the art-science have not been allowed to lie dormant. Perhaps in no other occupation is there such a field for discovery and improvement as in photography; and considering the many workers in it, and the large industry it represents, we may surely hope that in 1886 we may again be able to record a still further advance; it may be, perhaps, in the line I have already indicated, and in colour pictures.

OUR ASTRONOMICAL COLUMN

THE COMET OF 1686.—This comet, so far as the European observations are concerned, offers a very similar case to that of the comet of 1533, for which two totally different orbits have long appeared in our catalogues. As regards the latter, it was shown by Olbers that the observations of Apian between July 18 and 25 were insufficient to decide whether the true direction of motion was in the order of signs or the opposite, the node at the commencement of Leo or the end of Capricornus, or the perihelion in Cancer or in Scorpio; but the publication of the Chinese observations since Olbers wrote, has afforded evidence which tends to give the preference to his direct orbit, as already intimated in this column. The best observations of the comet of 1686, are those of Père Richaud at Pau, on four mornings between September 7 and 15; from his positions for the 7th, 10th, and 15th, the following orbit was obtained, and for the sake of comparison Halley's orbit, the only one previously computed, is copied.

	New Orbit.	Halley's Orbit
Perihelion Passage, G.M.T. ..	Sept. 19·2040 ...	Sept. 16·6063
Long. of Perihelion	23° 35′·4 .	77° 0′·5
,, Ascending Node ...	149 13·2 ...	350 34·7
Inclination	32 10 1 ...	31 21·7
Log. Perihelion Distance	9 48730 ...	9·51188
Motion.	Retrograde.	Direct.

If we compare these two sets of elements with Richaud's places, we find the differences between calculation and observation to be, for 16h. Paris M.T., as assumed time—

	New Orbit. Long.	New Orbit. Lat.	Halley's Orbit. Long.	Halley's Orbit. Lat.
	° ′	° ′	° ′	° ′
Sept. 6 ...	0 0 ...	0 0	+0 11 ...	−0 32
,, 8 ...	−1 18 ...	+0 11	−0 27 ..	0 0
,, 9 ...	−0 26 .	+0 14	+1 32 ...	−1 3
,, 14 ...	0 0 ..	0 0	−0 8 ...	−0 4

So that from these eight days' observations only it would be difficult to give a decided preference to either orbit. But it fortunately happened that before the comet was seen in Europe, it had been a very conspicuous object in more southern latitudes; at Para, in Brazil, it had been observed during the whole month of August, the nucleus as bright as stars of the first magnitude, with a tail 18° in length; in Siam by the French Jesuit missionaries, who its position approximately between August 17 and 23, and at Amboyna on August 15, a little south of the belt of Orion.

On comparing the two orbits with the Siam observations, it is at once evident that they decide in favour of Halley's elements, and on making a further calculation in which the August positions, which are only rough ones, are introduced, the following orbit finally results:—

Perihelion Passage, 1686, September 15·8249 G.M.T.

Longitude of Perihelion	75° 58′·4	Equinox of 1686.
Ascending Node ...	354 3·8	Equinox of 1686.
Inclination	34 55·7	
Log. Perihelion Distance	9·52636	
Motion ...	Direct.	

On the morning of August 17 the comet was distant from the earth 0·316, and at the time of Richaud's last observation, 0·973.

While writing on a cometary subject, we are reminded of what appears to be an unusual dearth of comets not of known period, in these parts of the system since the last one was detected by M. Borrelly on December 6, 1874, or more than eighteen months ago. It is true that generally the weather during this interval has been abnormally bad for such work as comet-hunting; still considering that several of the observers who of late years have given most attention to the search for these bodies, are located in very favoured climates, this appears hardly to explain the absence of any discovery. It may be anticipated that a systematic search for comets in the southern heavens will soon be organised by some zealous amateur in the other hemisphere; it is certain that he would in this way be likely to render material assistance in the advancement of cometary astronomy, and as we have before urged, he might succeed in bringing to light again one or two comets which were assuredly moving in elliptical orbits of short periods when last observed, but from one cause or another have since got adrift, and are not so likely to be recovered in the northern as in the southern hemisphere.

NEW MINOR PLANET.—M. Leverrier's *Bulletin International* of July 13 notifies the discovery by M. Paul Henry, at the Observatory of Paris, on the previous evening, of another small planet in R.A. 15h. 56m., N.P.D. 111° 59′. This planet, which is estimated 12·5m., is called No. 164, but it is to be remembered that we do not know the actual positions of so many as 164 of these bodies, and until the elements of any newly-detected one are well determined, there is the chance of identity with one or other of several which have been previously observed and even calculated, but for want of continuous observation are now lost.

A PHYSICAL SCIENCE MUSEUM

THE President of the Royal Society, Dr. Hooker; Mr. Spottiswoode; Dr. Burdon Sanderson; and Dr. Siemens, had an interview on the 17th inst. with the Lord President of the Council, the Duke of Richmond and Gordon, and presented the subjoined memorial from gentlemen who have been connected with the Loan Collection of Scientific Apparatus at South Kensington. His Grace discussed the subject of the proposed permanent Science Museum with the deputation, and stated that he would consult his colleagues.

MY LORD DUKE,

We, the undersigned, beg to submit for your Grace's consideration the importance of establishing a Museum of Pure and Applied Science; that is to say, a Museum to contain Scientific Apparatus, Appliances, and Chemical Products, illustrating both the history and the latest developments of Science; where the methods and results of investigations which have marked important stages in the advancement of Science may be studied, and where also the most highly perfected instruments of the day may be found.

Among the various advantages which in our opinion would accrue from the establishment of such an Institution,

we would mention the following. Investigators would be saved much time and labour by being enabled to see how far, and by what processes, others have advanced in the line of research which they may be pursuing: thus leading them to a knowledge of the facts and laws already established. From an educational point of view such a collection would assist teachers, by enabling them to select, or by showing them how to construct, the best apparatus for illustrating the subjects of their lessons. Great benefit would also accrue to the constructors of Mechanical and Philosophical Apparatus from being able to refer to the original Apparatus which they might be required to reproduce or to improve. To every one connected with Experimental Science, it would be of great service to see the actual instruments, many of which could otherwise be only known to them by description, and, under proper supervision and instruction to learn their actual manipulation and performance. We would also contemplate lending to investigators, under suitable restrictions, such instruments as might be profitably employed in the researches they were pursuing.

In considering this subject our attention has naturally been directed to the existing Museum of Patents. While fully recognising the value of many of the objects now belonging to that collection, we are of opinion that, as standing alone and purely as subjects of a patent, their value is far less than if they formed part of a general collection, and were placed in juxtaposition with instruments of a similar nature, some of which, though not patented, are better adapted to their purpose, and of greater instructional value. The object of a Scientific Museum is the promotion of knowledge, and the establishment of the scientific principles which must underlie all invention; and it would not only prove of great advantage to both scientific investigators and the public if the two objects could be combined in one undertaking, but we believe that the objects of a Patent Museum would be better served by a museum of the character here proposed than by a special collection, such as has hitherto subsisted. We are decidedly of opinion that the state of knowledge in reference to any invention would be only very imperfectly represented by the exhibition of patented instr uments and products only.

In support of the views which we have ventured to submit, we would draw your Grace's attention to the Fourth Report of the Royal Commission on Scientific Instruction, §§ 80-94. In § 93 the Commission state:-"We accordingly recommend the formation of a Collection of Physical and Mechanical Instruments; and we submit for consideration whether it may not be expedient that this Collection, the Collection of the Patent Museum, and of the Scientific and Educational Department of the South Kensington Museum should be united and placed under the authority of a Minister of State."

We understand that the Royal Commission for the Exhibition of 1851 has offered to erect a building for the purpose contemplated in this memorial, and we would desire to point out that the purchase of objects need not entail any large outlay of public money. We contemplate the gradual formation of a collection of such objects as might be voluntarily left at the close of the existing Loan Collection, and others which might be contributed from the existing Patent Museum and other public departments, from the parliamentary grants administered at the request of Government by the Royal Society, and from such private societies and individuals as might be disposed to avail themselves of the Museum as a depository of scientific apparatus, appliances, and chemical products.

We have the honour to be, my Lord Duke,
Your Grace's obedient Servants,

(Signed) J. D. Hooker, President of the Royal Society.
John Evans, F.R.S., Chairman of the Conferences in the Geographical Section.
E. Frankland, F.R.S., Chairman of the Conferences in the Chemical Section.
J. Burdon Sanderson, F.R.S., Chairman of the Conferences in the Biological Section.
C. W. Siemens, F.R.S., Chairman of the Conferences in the Mechanical Section.
W. Spottiswoode, Treasurer and Vice-President R.S., Chairman of the Conferences in the Physical Section.
Charles Brooke, F.R.S.
Alfred S. Churchill, Chairman of the Society of Arts.
William Kitchen Parker, F.R.S.
H. W. Bristow, F.R.S., Director of the Geological Survey of England.
William B. Carpenter, F.R.S.
Latimer Clark, late President Soc. Tel. Engineers.
W. H. Flower, F.R.S., Conservator Hunterian Museum.
J. H. Gilbert, F.R.S.
Robert Main, F.R.S., Radcliffe Observer.
Fredk. Jno. Evans, V.P.R.S., Capt. R.N., Hydrographer of the Navy.
P. de M. Grey Egerton, F.R.S.
Hampton, F.R.S., President of the Institute of Naval Architects.
Joseph Prestwich, F.R.S.
T. M. Goodeve, M.A.
W. de W. Abney, Capt. R.E., F.R.S.
G. W. Royston Pigott, M.A., M.D., F.R.S.
Robert H. Scott, F.R.S., Director Meteorological Office.
George Robert Stephenson, F.R.S., President Institute Civil Engineers.
F. H. Wenham.
George Bentham, F.R.S.
Nevil S. Maskelyne, F.R.S.
H. S. Eaton, President of the Meteorological Society.
E. Atkinson, Treasurer of the Physical Society.
F. A. Abel, F.R.S., President of the Chemical Society.
T. Hawksley, President of the Institute of Mechanical Engineers, past President of the Institute of Civil Engineers.
William H. Stone, F.R.C.P., &c.
W. J. Russell, F.R.S.
David Forbes, F.R.S.
Richd. Collinson, Vice-Admiral, Deputy Master of the Trinity House.
B. Woodcroft, F.R.S., late Superintendent of Patent Office Museum.
C. W. Merrifield, F.R.S.
Andw. C. Ramsay, F.R.S., Director General Geological Survey.
C. P. B. Shelley.
James Baillie Hamilton.
F. Eardley-Wilmot, F.R.S., Major-General.
Henry Cole.
Warren De La Rue, F.R.S.
Frederick Guthrie, F.R.S., Prof. Physics, Royal School of Mines.
C. O. F. Cator.
Thomas Savage.
Alfred Barry, D.D., Principal of King's College
Wm. Chappell, F.S.A.
A. J. Mundella, M.P.
William C. Unwin, Prof. Engineering, Indian C. E. College.
George T. Clark.
Joseph Woolley, LL.D.
John F. Twisden.
Richard Strachey, Major General, F.R.S.
Frank Bolton.
D. Glasgow.
William Rutherford, M.D., F.R.S.
Henry E. Roscoe, F.R.S.
J. Hopkinson.
A. W. Reinold.
John Tyndall, F.R.S.
John Torr, M.P.
Aberdare, President of the Royal Horticultural Society.
Robert James Mann, M.D.
Albert Gunther, V.P.R.S.

H. C. Rawlinson, F.R.S., late President Royal Geographical Society.
W. B. Baskcomb.
James K. Shuttleworth.
Geo. Busk, F.R.S.
Geo. J. Allman, F.R.S., President of the Linnean Society.
J. Arthur Phillips.
T. H. Huxley, Sec. R.S.
E. Ray Lankester, F.R.S.
H. C. Sorby, F.R.S., President of the Royal Microscopical Society.
W. T. Thiselton Dyer, Assistant-Director, Royal Gardens, Kew.
Henry W. Acland, F.R.S., President of Medical Council.
H. W. Chisholm, Warden of the Standards.
D. T. Ansted, M.A., Cant., F.R.S.
J. H. Gladstone, F.R.S., Fullerian Professor, Royal Institution.
J. Scott Russell, F.R.S.
A. Lane Fox, Colonel, F.R.S.
Rayleigh, F.R.S.
Robert S. Ball, LL.D., F.R.S., Astronomer Royal, Ireland.
H. C. Seddon, Major, R.E.
Charles V. Walker, F.R.S., President of the Society of Telegraphic Engineers.
Joseph Whitworth, F.R.S.
G. Carey Foster, F.R.S., President of the Physical Society.
Balfour Stewart, F.R.S.
R. B. Clifton, F.R.S., Professor of Experimental Philosophy, Oxford.
W. F. Barrett, Prof. Physics, Royal College of Science, Dublin.
J. Norman Lockyer, F.R.S.
Francis Galton, F.R.S.
J. Cameron, F.R.S., Major-General, Director Ordnance Survey.
M. Foster, F.R.S.
E. A. Schafer.
B. Samuelson, M.P.
E. Klein, F.R.S.
W. N. Hartley.
Francis Guthrie, LL.B.
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H. Dent Gardner.
John Allan Brown, F.R.S.
William Hackney.
Ettrick W. Creak, Staff Commander, R.N.
W. H. Preece.
W. Chandler Roberts, F.R.S.
A. B. Kempe, B.A., Barrister-at-Law, Western Circuit.
Alex. Crum Brown, Professor of Chemistry, Edinburgh University.
James Dewar, Professor of Mechanism, Cambridge.
Urban Pritchard, M.D.
R. H. M. Bosanquet, M.A., F.R.A.S., F.C.S., Fellow of St. John's College, Oxford.
Sydney H. Vines.
Alfred E. Fletcher.
Herbert M'Leod, Prof. of Experimental Science, Indian C.E. College.
Alex. B. W. Kennedy, C.E., Prof. Engineering, University College.
Arch. Geikie, F.R.S., Director, Geological Survey, Scotland.
Cornelius B. Fox, M.D., F.M.S.
Nicholas Brady, M.A.
Thomas Stevenson, F.R.S.E., F.G.S., M. Inst. C.E.
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J. E. H. Gordon.
W. Galloway, Prof. Chemistry, Royal College of Science, Dublin.
Henry E. Armstrong, F.R.S.
Thomas Andrews, LL.D., F.R.S., President of the British Association.
James Thomson Bottomley, M.A., F.R.S.E.
W. F. Donkin.
Claude R. Conder, Lieut. R.E.
Charles E. De Rance, F.G.S., H.M. Geological Survey.
Nathl. Barnaby, Chief Constructor of the Navy.
W. Topley.
J. Clerk Maxwell, F.R.S., Prof. of Experimental Physics in University of Cambridge.
G. G. Stokes, Sec. R.S. Lucasian Professor, Cambridge.

NOTES

THE current number of the *Fortnightly Review* contains an article by Dr. Bridges, in which he tries to prove that Harvey did not discover the circulation of the blood by vivisection. Harvey's own statements are so explicit, and the methods he employed have been so often expounded, that there is little new to be said on the point. Harvey, as Dr. Bridges admits, discovered the true functions of the heart, and inferred the existence of the complete systemic circulation by observations on living animals, interpreting the facts observed by aid of the faculty of reasoning. Malpighi demonstrated the capillary part of the circulation by other observations on living animals, dealing with his new facts by aid of the same faculty. But to say that the movements of the heart were discovered by vivisection and the brains of Harvey, but the circulation of the blood "by the microscope of Malpighi" is as absurd as to ascribe the glory of the former discovery to Harvey's scalpel and that of the other to Malpighi's brains.

THE following are the numbers of visitors to the Loan Collection of Scientific Apparatus during the week ending July 15:—Monday, 3,464; Tuesday, 3,300; Wednesday, 602; Thursday, 495; Friday, 451; Saturday, 3,403; total, 11,715. During the present week 13 demonstrations of apparatus were given on Monday, 11 on Tuesday, 5 on Wednesday; 6 are to be given to-day, 5 on Friday, and 5 on Saturday.

THE annual meeting of the Helvetic Society of Natural Sciences will take place at Basle, on August 20-23. Scientific men of all countries are cordially invited to the meeting; and those who wish to make any communication are requested to write, before August 1, to Dr. H. Christ, 5, Baumleingasse, Basle.

THE Scientific Societies of Belgium held their first united Congress at Brussels this week, from the 16th to the 18th. The following, we learn from the *Society of Arts Journal*, are some of the subjects which have been discussed:—Greater facilities for the transmission of scientific objects; as to the opening of public scientific institutions at convenient hours, and especially in the evening; the organisation of libraries and scientific collections in the towns and communes; the publication of elementary treatises on various branches of science; establishment at one of the littoral towns of a collection of works concerning the coast; a study of the geological formation of the district round Brussels; the part played by molluscs in nature; the malacological zones of Belgium. On the 18th there was to be a scientific excursion into the environs of Brussels.

AT a meeting of the Council of the Yorkshire College of Science, held last Friday, an offer by Mr. George Salt, of 150*l.* a year for three years as a temporary provision for a professorship of Biology, was accepted, Mr. Salt's stipulation that Mr.

L. C. Miall, F.G.S., be appointed professor being also agreed to. Mr. Miall will also deliver a short course of lectures annually at Bradford.

We rejoice to hear that *L'Explorateur* was mistaken in announcing the death of Dr. Petermann. The French journal seems to have been led astray by the death of Prof. A. H. Petermann, the distinguished orientalist.

On Saturday, July 8, the French and Swiss Alpine Clubs met together at Giromagny, to ascend a number of mountains in the French Vosges; a number of interesting observations were made.

The Awards made by the Council of the Institution of Civil Engineers for original communications during the Session 1875-76, have just been announced. Fifteen out of twenty-three communications have been rewarded, including a Telford medal and premium for "Motion of Light Carriers in Pneumatic Tubes," by Prof. W. C. Unwin, B.Sc. Telford premiums have been bestowed for "Movement of Air in Pneumatic Tubes," by C. Bontemps; "Pneumatic Transmission of Telegrams," by R. S. Culley and R. Sabine; "Floods in England and Wales in 1875," by G. J. Symons; "Evaporation and Percolation," by C. Greaves; "Tidal Changes in the Mersey," by J. N. Shoolbred, B.A. The Miller Scholarship of the value of 40*l.* a year for three years was gained by the Hon. R. C. Parsons, B.A., for an inquiry into the "History and Theoretical Laws of Centrifugal Pumps."

Mr. W. Vivian, of Mwyndy, Llantrisant, Glamorganshire, sends us the following instance of a joint-stock concern in the poultry yard. Two hens sat on, or by, one nest, and thus between them hatched one chick. They have since, for some weeks been parading the yard, each clucking and manifesting all the anxiety and care of a true mother over this one. The hens never quarrel, or show the least appearance of jealousy or rivalry.

A meeting of the West Riding Geological and Polytechnic Society was held at Settle on Wednesday week. The meeting was well attended, and Mr. Tiddeman gave an excellent address on the history, method of working, and the results that have been brought to light by the exploration of the Victoria Cave, Settle.

Further particulars have been published concerning Gessi's circumnavigation of Lake Albert Nyanza. He found it 140 miles broad by 50 wide. No river of importance enters it, the south end is shallow, and the lake seems subject to violent storms. The true Nile, after leaving the lake south of Duflé about 100 miles, splits into two branches, one of which goes to Duflé and Gondokero, the other, the natives say, goes far inland. Colonel Gordon had no news of Stanley on May 2, but expects he went across from Victoria Lake, saw the south end of Albert Lake, and has got into a nest of lakes, which, Colonel Gordon thinks, exist between the Albert and the Tanganyika.

We have received the Proceedings of the American Oriental Society for May and November, 1875, and May, 1876. At these meetings many valuable papers on the department with which the society is connected, were read; among these is one by Prof. W. D. Whitney replying to some criticisms of his work by Prof. Max Muller.

The Paris Society of Agriculture and Insectology has asked from the Municipal Council of Paris, whose zeal for instruction is laudable, the grant of a piece of ground at Montsouris for the purpose of establishing a model apiary, a botanical collection of all plants likely to be of use in feeding bees, a model establishment of sericiculture, and a collection of all trees likely to be of use in feeding silkworms. The request is to be granted on condition that the establishment be open free to the pupils c the several municipal schools.

Satisfactory accounts are given of the boring of the shai for the Channel Tunnel. A depth of 80 yards has bee reached, and no fault has been observed from which any diffi culty may be expected in the execution of the Tunnel.

Violent shocks of earthquake were felt again on the 5tl inst. at Corinth and the surrounding district. The direction c the motion was east to west. Shortly after noon on Monday a earthquake occurred in Vienna. Three violent shocks, lastin two seconds, were felt. A panic ensued. Several houses ar damaged, and a portion of the old walls has been split.

We have received the Forty-second Annual Report of th York School Natural History, Literary, and Polytechnic Societ This must surely be the oldest School Society in the kingdon The Report, of only four pages, shows that a considerab amount of work has been done in the various departments wi which the Society deals, and we should think that the Socie is an important element in the educational means of the schoo

The Twelfth Annual Report of the Lewes and East Suss Natural History Society states that the Society is numerical and financially in good condition. The Society is doing a fa amount of good field-work, and contemplates the publication lists of the fauna and flora of East Sussex.

The *Geographical Magazine* for July contains a paper, wi maps, by Mr. Ravenstein, exhibiting some interesting conclusio as to the birthplace and migrations of the populations of t British Isles, drawn from the census tables. The magazine al contains some important statistics on Danish Greenland, furnish by Dr. Rink, a paper on the Andaman Islands, an account Schweinfurth and Güssfeldt's recent journey into the Arabi Desert of Egypt, and a vindication of genuineness of Verrazan narrative, by Mr. R. H. Major.

The Municipal Council of Paris has voted, in accordance w the suggestion of M. Leverrier, a sum of 30,000 francs for t purpose of constructing precision clocks at the Exchange, Tribu de Commerce, and Hôtel de Ville. A competition will opened between the clock-makers. All these clocks are to connected together electrically, and will distribute the time the several parts of the city. The perplexing discrepa between the different public clocks in Paris will be abolis entirely.

A meeting was held on Tuesday in connection with the p posal to establish a Museum of Hygiene at University Colle London, as a memorial to the late Dr. E. A. Parkes, F.R Subscriptions to the amount of 675*l.* were announced.

Mr. Prescott G. Hewitt, F.R.S., has been elected Pr dent of the Royal College of Surgeons for the ensuing year room of the retiring President, Sir James Paget.

At a recent meeting of the Paris Academy, M. Woillez scribed an apparatus which he calls a *spirophore*. It is for resuscitation of asphyxiated persons, especially those who h been in danger of drowning, and newly-born infants. It c sists of a sheet-iron cylinder, closed at one end. The bod the individual is introduced up to the neck, the aperture ro which is then closed by a diaphragm. A strong bellows, c taining more than 20 litres of air, situated without the case, c municates with this by a wide tube, and is worked by a le the descent of which causes the air to be drawn off from case, while the return motion restores the air. Through a p of glass in the cylinder, the chest and abdomen of the pa can be seen, and a rod, movable in a vertical tube, rests or sternum. When a vacuum is made about the body by depre

the lever, the external air penetrates into the chest, the walls of which rise as in life. They return to their former position when the lever is raised, and these respiratory movements may be repeated fifteen to eighteen times a minute, as in a living man. By means of a tube communicating with a reservoir, and inserted in the windpipe, M. Woillez found that a litre of air, on an average, entered the air passages at each artificial inspiration, whereas the physiological average is only a demi-litre. Thus, more than a hundred litres of air can be passed through the lungs of an asphyxiated person in ten minutes. There is no danger of rupturing the lungs, however strongly the lever be wrought, for the force of penetration of the air is never superior to the weight of the atmosphere.

THE direction of plant-growth, it is known, is determined both by light and by gravity. The geotropism, or action of gravity exclusive of light has before been examined; and recently M. Müller (Thurgau), we learn from *Flora*, has endeavoured to study the converse fact of heliotropism, by excluding the influence of gravity as far as possible. He grew his plants in a cylinder rotating about its horizontal axis. The apparatus was so arranged that the light, coming through an aperture in the shutter of a dark room, fell parallel to the axis; the bendings observed were thus purely heliotropical. Among other results he found that only those zones which were not fully grown out, showed heliotropic bendings; that the most strongly growing parts of the stem were most sensitive to one-sided illumination; that the bending takes some (variable) time to manifest itself and continues some time after removal of the cause; that the rate of bending is at first slow, gradually increases to a maximum, and thereafter diminishes; that the bending is greater the intenser the light, &c.

IN the *Upsala Universitets Arsskrift* for 1874, Dr. Hamberg gives a most interesting paper, illustrated with eight coloured maps, on the night-frosts which have occurred in Sweden during 1871-72-73, from May 20 to September 30, or during that portion of the year of most interest to agriculturists. The observations of 285 Swedish observers are elaborately discussed, from which it appears that 80 per cent. of these frosts occur with northerly winds on the day preceding and on the days following them, but that during the night of the frost either the wind is very light or the air is calm. The map exhibiting the distribution of the spring frosts shows an abnormal excess on the south or lee side of the great lakes, arising, in all likelihood, from the low temperature of these lakes in spring. In autumn, on the other hand, when the temperature of the lakes is high, no such excess of frosts occur over the region south of them. One of the most striking results is the relatively small number of frosts over the district immediately to the north of Lake Wener, a result which may be due to the remarkable deflection of the wind in summer over this part of Scandinavia, so that winds are there south-westerly when they are north-westerly and westerly on the west of Norway. Six of the maps show well the intimate relation existing between the frosts and areas of high barometric pressure, and suggest that, if desired, the telegraph might be employed to give warning of these frosts, which are so destructive to vegetation.

THE *Supplemento alla Meteorologia Italiana* for 1875, fasc. iii., is entirely occupied with an exhaustive discussion of the temperature of Modena, by Prof. Ragona, director of the Royal Observatory there, based on the observations of the twelve years ending 1874. Among the more interesting points discussed with considerable fulness, are the anomalies of temperature which have occurred during the twelve years, particular attention being given to those anomalies which show a tendency to recur about the same dates from year to year. The prevailing winds at Modena are west and south-west from November to February and north-east during the other months, and the changes of these winds is a point of the greatest importance in their relations to the anomalies of temperature which accompany them. Fasc. iv. contains an account by P. A. Serpieri, director of the Observatory of Urbino, of the earthquake which occurred in the night of March 17-18, 1875; and a notice, by Almerico da Schio, of the stations established, or in the course of being established, in the province of Vicenza, for meteorological observations, or for observations of rainfall, of weather, or of the depth of the rivers. Upwards of sixty such stations are indicated on the map of the province accompanying the paper.

TWO important publications, constituting Nos. 5 and 6 of the *Bulletin* of the U.S. National Museum, by Mr. G. Brown Goode, Assistant Curator of that establishment, have lately been published by the Interior Department. The first, a catalogue of the fishes of the Bermudas in the collection of the museum, gives the first complete account of the ichthyology of that portion of the world. These were principally obtained by Mr. Goode during a visit to the islands in the months of February and March, and are notes on the character of the species, containing many important facts in regard to their natural history. Seventy-five species in all were actually obtained, and the existence of others determined, but not established by specimens. A chief value of the paper is in the description of the colours of the fish while living, and the notes on their size and hints on their popular names, their capture, and economical value. The second publication was prepared by Mr. Goode as a classification of the collections made by the Smithsonian Institution and the United States Fish Commission for the Centennial Exhibition at Philadelphia.

THE additions to the Zoological Society's Gardens during the past week include two Royal Pythons (*Python regius*) from West Africa, presented by Mr. J. J. Kendall; a Greater Sulphur Crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mrs. Baliol Scott; two Striped Hyænas (*Hyæna striata*), an Alligator (*Alligator mississippiensis*) from North America; two American White Cranes (*Grus americana*) from North America; a Green-winged Trumpeter (*Psophia viridis*) from Brazil, purchased; three Shoveler Ducks (*Spatula clypeata*) hatched in the Gardens.

SCIENTIFIC SERIALS

Journal of the Chemical Society, April.—A paper on oxynarcotine, a new opium educt, and its relationships to narcotine and narceine, is contributed by Dr. Wright and Mr. G. H. Beckett. This new body is obtained from an indistinctly crystalline mass, which, during the preparation and purification of narceine from opium liquors, is often left undissolved on boiling the partially purified narceine with water. This crude product contains the new opium alkaloid, bearing to narcotine the relationship of benzoic acid to benzoic aldehyde.—Dr. H. E. Armstrong and Mr. George Harrow contribute two papers: one on the action of potassic sulphite on the haloid derivatives of phenol, the other on the action of nitric acid on tribromophenol. The length of the chemical names made use of in these papers is positively alarming, *e.g.*, dichlorophenolorthosulphonate and diorthobromoparanitrophenol.—Mr. Cornelius O'Sullivan contributes a paper on maltose, which is intended to show that maltose, obtained by the action of malt-extract on starch, is a simple body, isomeric with cane-sugar, and not a mixture of dextrin with dextrose, as M. Bondonneau, in a note recently presented to the Academy, regards it.—Mr. M. M. Pattison Muir, F.R.S.E., gives a method of estimating bismuth volumetrically. Potassium chromate or potassium dichromate solution is run into a nearly neutral solution of bismuth nitrate until the whole of the metal is precipitated in the form of chromate. The final point of the reaction is determined by the formation of red silver chromate, when a drop of

silver nitrate is brought into contact with a drop of the supernatant yellow liquid.—Mr. Thomas Fletcher gives a brief note on a simple form of gas regulator, differing only in form from one described by Mr. Page in the January number of the *Chem. Journ.* for 1876.—Mr. Thomas Carnelley, B.Sc., F.C.S., contributes a paper on high melting-points, with special reference to those of metallic salts. The author describes a new method which he proposes for determination of high melting-points, and the results of his investigations by this new method. The principle of this new method is as follows:—In a platinum crucible a small quantity of a salt is placed, and the crucible suspended in the flame of a Bunsen's burner or of a blowpipe. If the temperature at which the salt fuses is not above a certain point, the temperature of the crucible after a time reaches that point. If, at the instant the salt is seen to melt, the crucible be dropped into a known weight of water of known temperature, and the rise in temperature noted, from the equation for specific heats, we obtain the initial temperature of the crucible at the time the salt melted, and hence the temperature at which the fusion occurred, assuming that the mean temperature of the crucible is the same as that of the salt at the moment of melting.—Numerous abstracts of papers published in other journals, together with a full account of the anniversary meeting of the Chemical Society, complete the contents of this number.

American Journal of Science and Arts, June.—We have here some interesting observations on Saturn, made by Mr. Trouvelot during the last four years with the refractors at Harvard, Washington, and Cambridge Observatories. He notes, *inter alia*, some singular dark angular forms on the inner margin of the first ring, outside the principal division of the rings; it seems due to a jagged conformation. The three outer rings have shown a mottled or cloudy appearance on the ansæ; the cloud-forms at some parts attain different heights, and change their relative positions. The dusky ring is not transparent throughout, as has been supposed; and it grows more dense as it recedes from the planet, so that, at about the middle, the limb of the planet ceases entirely to be seen through it; further, the matter of this ring is agglomerated here and there into small masses.—The "1474" line, which is reversed in the spectrum of the solar corona, coincides with one of the short lines in the spectrum of iron. It appears in ordinary spectroscopes like a fine hard black line; but in lately examining this part of the spectrum with a diffraction spectroscope armed with a silver glass "gitter platte" of 8640 lines to the inch, Prof. Young found the line to be unmistakeably double. The more refrangible line he regards as the real corona line; the other belonging to the spectrum of iron. —Mr. J. Lawrence Smith, in a paper on carbon compounds in meteorites (here concluded) arrives at some important results. The phenomena of the graphite nodules are very puzzling; the presence of such substances as free sulphur, and a hydrocarbon in the interior of the graphitic concretions was certainly not to be expected. We now know of celestial carbon (Mr. Smith says) in three conditions, viz., in the gaseous form as detected by the spectroscope in the attenuated matter of comets; in meteorites in the *solid* form, impalpable and diffused through pulverulent masses of mineral matter; also in the *solid form, but compact and hard*, like terrestrial graphite, and imbedded in metallic matter, that comes from regions in space.—From experiments on the diminution of the minute distance between two surfaces in contact, with the increase of the contact pressure (the substances being iron, brass, and plate glass), Prof. Norton found that the diminutions were very nearly the same, whatever the nature or condition of the surfaces in contact; that they were nearly independent of the extent of the surface in contact; and that the diminution of contact-distance for an increase of one ounce in the pressure, was nearly inversely proportional to the pressure.—Mr. Carey Lea describes experiments on the sensitiveness of silver bromide to the green rays as modified by the presence of other substances. Finding no red substance capable as such of increasing this sensitiveness, and on the other hand, many colourless substances which have that effect, he is confirmed in the opinion that there is no relation between the colour of a substance and that of the rays to which it increases the sensitiveness of silver bromide.—We further note a translation of M. Hartt's first report on the geological survey of Brazil, a paper by Mr. King on palæozoic divisions on the fortieth parallel, and an account of a nebula photometer, by Mr. Pickering.—Prof. Marsh describes some new fossil birds.

Archives des Sciences Physiques et Naturelles, Feb. 15.—From researches on the specific heats of saline solutions, described in this number, M. Marignac concludes that the specific heat depends not solely on the nature of the acids and bases of the salts; so that one cannot calculate it from their composition. It may be modified by other causes special to each salt, and the nature of which is still unknown. These causes do not seem to be connected with the greater or less tendency of salts to combine with water and form definite crystallisable hydrates.—It is a disputed point among physiologists whether fat is a product of decomposition of albumen. M. Secretan here describes an investigation on the subject. His experiments were on albumen decomposed in current water, and in the ground. He considers that the transformation in question is improbable, and accepts Orfila's theory, that the fat of dead bodies is only formed where there is already fat present, and an azotised matter.—In a paper on the constituents of woman's milk and cow's milk, M. Lachenal finds that the latter is richer in nitrogen, and consequently in albumenoid substances than the former, in the proportion of 3·51 to 2·53. After coagulation, the serum of cow's milk no longer contains either caseine or albumen, whereas the serum of woman's milk holds in solution a quantity of albumenoid matters which may be estimated at a half of the nitrogenised substances of the milk.—M. Gillieron studies the traces of ancient glaciers of the valley of the Wiese in the Black Forest.—In a reply to M. Soret, on the temperature of the sun, M. Violle describes some interesting observations on the radiation from incandescent steel.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 18.—"Note on a Simultaneous Disturbance of the Barometer and of the Magnetic Needle," by the Rev. S. J. Perry, F.R.S.

Linnean Society, June 15.—Prof. Allman, president, in the chair.—Prof. Rolleston read an interesting paper on the prehistoric pig of Britain, illustrating this by a series of skulls of species, wild and tame.—Dr. Masters followed by remarks on the superposed arrangement of the parts of the flower. The alternate arrangement in the parts is so general that exceptions are invested with peculiar interest. "Alternate" and "superposed" the author used in preference to the term "opposite," and he stated superposition exists in a large number of very diverse families. He then gave instances of apparent or false superposition in certain of the cultivated varieties of Camellia, &c. Real superposition may arise from (1) superposition of whorls, exemplified in the monstrous Daffodil (*Narcissus Eystettensis*; (2) spiral arrangement of parts, *e.g. Sabia*; (3) enation, chorisis, between which it seems necessary to draw a distinction, although the differences in the adult flower may not be always obvious (in chorisis the original organ is repeated, in enation the process is subsequent to the first stages of development, example scales before the petal in *Silene*); (4) abortion or suppression of intermediate whorls, *e.g*, Vine, &c.; (5) pleiomery, when numbers of successive whorls are unequal, some of the additional parts become superposed *Nigella* cited; (6) substitution of one organ for another, in *Zanthoxylum*; (7) torsion of the axis, either between two successive whorls or of constituent elements of whorl, exemplified in leaves rather than flower.—Dr. Masters then drew attention to illustrations of the relative position of the perianth and andrœcium in genera of the *Ulmaceæ* and *Olacaceæ*.—A paper by Dr. J. Anderson on the skeleton and feathering of the spoon-billed sandpiper (*Eurynorhynchus pygmaeus*) was read, and Mr. E. Harting in exhibiting skins of this rare Indian bird and its allies, made remarks thereon. Dr. Anderson shows that, excepting deviation in the bill, *E. pygmaeus* in detail agrees with the genus *Tringa*.—Mr. W. Archer gave a summary of a paper of his on the histology and development of the genus *Ballia*. The material for research was furnished partly by the *Challenger* and partly by the Transit of Venus expeditions, and obtained in Kerguelen's Land. The author found that the septa separating contiguous cells contained circular "pits" which were closed by plano-convex "stoppers," the purpose of which is difficult to determine. The pits do not communicate and the pair of stoppers, easily disturbed from their positions, resemble a rivet passing through the septum. He further described the peculiar manner in which the cells of the rachis are jointed together, the mode of development of the branches, the origin of the cortical investment of confervoid filaments, and tantamount modifications in nearly-allied species.—A second communication of Mr. Archer's was on fresh-water algæ collected

by Mr. Moseley in Kerguelen's Land.—Prof. Duncan then delivered an oral epitome of a joint research by himself and Major-General Nelson, R.E., on some points in the histology of certain species of Corallinaceæ. Quekett, about 1851, gave a good account of the minute textural peculiarities of the hard structures of corallines generally, and in 1866 Rosanoff published a memoir on the Melobesiæ, therein bringing to light many details of the softer structures omitted by the former. Major-General Nelson and Prof. Duncan now supplement the foregoing by further microscopic investigations on the living forms of Bermuda and Britain. On the shores of the former island the high and constant temperature conduces to a development and growth of the corallines not witnessed on our own sea-board, and the colours, moreover, are rich in proportion; for these and other reasons a more complete study of their development and physiology has been made. Starting from Quekett's and Rosanoff's labours, the recent researches show the presence of remarkable filamentous appendages to the dermal layer, which latter is composed of a loose cellular envelope, permitting the existence of large sub-dermal areas. The interior more aggregated cellular substance has certain radiating fibres running through, and which are modified at the joints. The growth of the cell-structure, semilunar bodies developed in the primordial utricle, the manner in which the deposition of carbonate of lime takes place, and other interesting facts, the authors elucidate and place on record. —Mr. R. B. Sharpe, in exhibiting a collection of birds from South-east New Guinea, collected by the Rev. S. McFarlane, and now deposited in the British Museum, pointed out that most of the forms had already been obtained by former travellers, though one species, *Graucalus augustifrons*, was new to science, as probably was a Bird of Paradise, so injured, however, as to prevent a correct description being made. The nest of a Bower-bird was also commented on.—A memoir on the Oxystomatous crustacea, by Mr. E. I. Miers, was taken as read, also two papers on New Zealand Ferns, by Mr. J. H. Potts; and notes on algæ collected by Mr. Moseley, of the *Challenger* Expedition, by Prof. Dickie; besides a paper by the Rev. J. M. Crombie, on lichens from the Island of Rodriguez, obtained by Dr. I. B. Balfour, 1874.—In an additional note relative to the Norwegian Lemming, Mr. W. Duppa Crotch referred to some recent information obtained supporting his formerly expressed views.—In the form of an oral abstract, Mr. S. H. Vines gave a lucid account of some late experiments and chemico-physiological investigations of his into the nature of the digestive ferment of *Nepenthes*. In the Pitcher-plant, at least, he pretty clearly proves that a secretion and other phenomena equivalent to the digestive process of animals obtains.

Anthropological Institute, June 27.—Col. A. Lane Fox, F.R.S., president, in the chair.—The election of two new members was announced.—Mr. Walhouse exhibited arrow-heads from Southern India, closely resembling forms met with by Lieut. Cameron in Central Africa.—Remains of red deer, wolf, with portions of a human skull, from the foundation of the Bath gas-works, were exhibited by Miss A. W. Buckland.—Mr. Hyde Clarke read a paper on serpent and siva worship and mythology in America, Africa, and Asia. The first part of the paper was devoted to an account of the Bribri and other Indians of Costa Rica in Central America, and of the immediate relations of their languages to those of Western Africa. This furnishes another connection of language besides the Carib with the Dahomey, the Guarani with the Agan and Alkhass, and the Quichua, Aymara and Maya, with Accad and Cambodian. The rest of the paper was devoted to trace the Central American one god Sibu, and his mythology to the old world. This word, as Sowo and Nebo, is in company found with Kali in West and Central Africa, over a wide area, representing god, spirit, idol, navel, &c. It was then illustrated with Siva and Kali, and the cosmogony and serpent worship in India; and further with Nebo in Babylonia, Seb in Egypt, Seba in Arabia and Phrygia. The title Sabaoth was referred to. The American legend appeared to point to a unity of God in the prehistoric epoch.—Mr. Park Harrison described marks found last summer on the chalk at Cissbury, some upon the walls of the galleries, and the remainder on rounded pieces of chalk.—Dr. Gillespie read a short note on the use of flint cores as tools.—The remaining papers were "on the term Mediterranean," as applied to a part of the human race; and a minute account of the Javanese, Mr. Kuhl.

Physical Society, June 24.—Prof. G. C. Foster, president, in the chair.—The following candidates were elected members of the Society:—Prof. James Dewar, F.R.S.E., and the Hon. F. A. Rollo Russell.—Prof. Guthrie showed the action of Prof. Mach's apparatus for exhibiting to an audience the effect of lenses on a beam of light passed through them. It consists of a long rectangular box with glass sides, in which are several movable lenses. A parallel beam of light falls on a grating at one end of this box and is thus split up into a number of small beams, which are rendered visible by filling the box with smoke. After passing through the first lens the rays fall on a movable white rod, which may be placed to indicate the focus. The light then falls on another lens partly covered with red and partly with blue glass in order to more precisely exhibit the paths of the rays.—Baron Wrangell exhibited the apparatus employed by Petrochovsky in his magnetic experiments. These experiments had reference to (1) normal magnetisation, (2) the measurement of the distance of the poles of a magnet from its ends, and (3) a thermo-electric apparatus. The determinations were very much simplified by employing a unipolar magnetic needle, formed by bending a small bar magnet at right angles at about a quarter of its length from one end. The needle is then suspended by a fibre attached to the end of the short arm, and the longer arm is maintained horizontally by a brass counterpoise weight. It will be evident that as one pole is in the axis of rotation, it cannot have any effect on the motion of the needle. By turning up each end in this manner the moment of the magnet may be ascertained without knowing the exact positions of the poles. If a magnetic needle be so placed that a bar magnet parallel to it has no effect in deflecting it from the meridian, and the bar be then struck with a brass hammer, the state of equilibrium will be disturbed, as is shown by the motion of the needle. This, however, is not the case with a piece of soft iron round which an electric current is passing. The apparatus employed in the experiments on "normal magnetisation" consisted of an arrangement for passing a current round rods of soft iron of varying lengths, so constructed that any number of the surrounding coils can be removed in the manner of an ordinary rheostat. After the current has been passed round the bar, it is moved until its residual magnetism has no effect in deflecting a delicate unipolar needle from the meridian. The current is then passed round it, and the coils are adjusted until the magnetised bar has still no effect on the needle. The effect of the coils themselves is counteracted by means of a subsidiary coil. When the current is thus adjusted, the bar is said to be "normally" magnetised, and M. Petrochovsky has ascertained that this condition is satisfied when the length of the coil is 0·8 times that of the bar, and this is independent of the strength of current. This, then, is the only case in which the position of the poles is the same as when the bar is charged with residual magnetism. For the determination of the positions of the poles of a bar magnet a somewhat complicated apparatus was employed. A large unipolar magnet about eight inches in length, provided with a bifilar suspension, was enclosed in a glass box. A fine silver wire was stretched parallel to the axis of the needle between two projections on it, and it also carried a fine index at the horizontal end. The wire is focussed in a telescope which can be made to travel along rails parallel to the magnet, and the index at the end can be observed by another telescope. A small magnet at right angles to the large magnet can be moved with the first telescope, and the point at which its effect in deflecting the unipolar is the greatest is ascertained by varying its position parallel to itself along a graduated scale and then observing the space through which a subsidiary magnet must be moved in order to restore the unipolar to its original position, as observed in the second telescope. When this point is reached it must be exactly opposite the pole of the large magnet. It was thus found that the poles are at a distance of one-tenth of the length of the magnet from its ends. To determine the position of the poles of a horse-shoe magnet a delicate magnetic needle is placed below a fine wire in the meridian and a horse-shoe magnet is brought so that its two ends are immediately below the wire and near the needle. In the case of an electro-magnet the point at which its effect is greatest is found to vary when the coils are moved towards the ends, and is nearest to the ends when the coils project slightly beyond them. The third series of researches referred to was on the influence of an electric current on the thermo-electric action of soft iron. A number of strips of iron are connected by means of copper studs, and when currents are passed round the alternate strips it is found that the system acts as an ordinary thermopile. This question is, however, still under investigation. In reply to a question of the President, Baron Wrangell stated that the effects of increasing the number of coils in the horse-shoe

magnet on the position of the poles is also still under investigation.—Prof. Barrett then made a brief communication on the magnetisation of cobalt and nickel. He has recently made some experiments on these metals with a view to ascertain whether they undergo any elongation or contraction similar to that experienced by iron during magnetisation. From this first experiment he concluded that cobalt elongates slightly, but that there is no effect on nickel, but this latter result may have been due to the fact that the metal was not absolutely pure. He has, however, obtained through Mr. Gore a fine bar of pure nickel about two feet in length, and now finds that it contracts, and that the amount of this contraction is about the same as the expansion of a like iron bar when similarly treated.—Prof. Guthrie then described some experiments on the freezing of aqueous solutions of colloid substances, which he has been studying in connection with his recent investigations on cryohydrates, &c. If a solution of sugar be gradually cooled the temperature at which ice separates out is always below 0° C., and the extent below increases with the amount of sugar in solution; but he finds that in a solution of gum having exactly the same chemical formula, the ice always separates at 0° C., whatever be the amount of gum present. Thus while every crystalline substance forms a freezing mixture when mixed with ice or snow, colloids are incapable of doing so. The gum and the water do not recognise each other: and similar results were obtained in the case of gelatine and albumen. These facts are strictly in accordance with the results of Prof. Graham's classical researches. It almost follows that, when heated, similar effects are observed, and Prof. Guthrie has found that solutions of gum in varying proportions always boil at 100° C. Mr. W. Chandler Roberts said that this important discovery was one that his late distinguished master would have welcomed, and he expressed a hope that Dr. Guthrie would continue his experiments with the series of colloids actually prepared by Graham.—Prof. Guthrie then showed the experiment by which Dr. Kerr has recently proved that glass, resin, and certain other substances exhibit a depolarising effect when under the influence of a powerful electrical tension. With the help of Mr. Lodge, Dr. Guthrie has succeeded in repeating these exceedingly delicate observations, but the effect is very slight and ill-suited for the lecture-room. A beam of polarised light traverses a thick plate of glass in which two holes have been drilled nearly meeting in the centre, and two wires are fixed in these and connected with the terminals of a powerful coil. The light after passing through the analyser falls on the screen. If now the analyser be so turned that the illumination is least before the current is turned on, the brightness of the field will be seen to increase as soon as the circuit is closed, and this brightness will increase up to a certain limit. The effect is greatest when the light is polarised at an angle of 45° to the line joining the terminals.—The President then adjourned the meetings of the Society until November.

PARIS

Academy of Sciences, July 3.—Vice-Admiral Paris in the chair.—The following papers were read:—On the fermentation of urine, by MM. Pasteur and Joubert. The ferment of urea, M. Musculus considers of the class of soluble (and not organic) ferments. The authors affirm that his soluble ferment is produced by the small organic ferment of urea.—Observations on M. Pasteur's communication, and on the theory of fermentations, by M. Berthelot.—Reply by M. Pasteur.—Note on M. Cros' paper regarding photographic reproduction of the colour of bodies, by M. Becquerel.—On the carpellary theory according to the Amaryllideæ (third part: Galanthus, Leucoium), by M. Trecul.—Third note on electric transmissions through the ground, by M. du Moncel. The currents due to difference of humidity in the ground about the plates arise through difference in facility of oxidation. Those due to unequal extent of surface of the plates arise because the electric action from physical contact of two heterogeneous bodies varies with their surface of contact, and because oxidable bodies are more attacked when they present a small surface to oxidation, than when they present a large.—Examination of new methods proposed for finding the position of a ship on the sea (continued), by M. Ledieu.—New series of observations on the protuberances and solar spots.—Letter from R. Secchi (June 28). A table is given for the first six months of 1876. Few protuberances; hardly any eruption; threads of gas rising straight and vertically, and of short duration. The issuing hydrogen seems to push aside the darker layer of absorbing metals, and thus produce very small faculæ. Since March almost no spots with nucleus and penumbra. Maxima of activity in latitudes 10° to 20°, and 50° to 60°.—On a luminous phenomenon at Port Said and Suez, on June 15, by M. de Lesseps. This was a luminous globe which burst like a rocket, with loud detonations.—On the metallic nickel extracted from ores of New Caledonia, by MM. Christofle and Bouilhet.—On the mode of employment of sulpho-carbonates, by M. Jaubert.—Present state of vines subjected to treatment with sulpho-carbonate of potassium since last year, by M. Mouillefert.—Experiments on the destruction of Phylloxera, by M. Marion.—Automatic discharges for electro-atmospheric rods, by M. Serra-Carpi.—On Glaucoma and the climate of Algeria by M. Tavignot.—Studies of astronomical photography, by M. Cornu. Any telescope may be immediately adapted for it by separating the two lenses of the object-glass, by a distance depending on the glass, but rarely more than 1½ per cent. of the focal distance. The original achromatism of the visible rays is transformed into achromatism of the chemical rays necessary for photographic images, and there is no aberration in the images.—On linear differential equations of the second order, by M. Fuchs.—On the isochronism of the cylindrical regulating spiral, by M. Caspari.—On Mr. Crookes's radiometer, by M. Govi.—On the explanation of the motion of the radiometer by means of the theory of emission, by M. de Fonvielle.—On the radiometer, by M. Ducretet.—New peroxide of manganese battery, by M. Leclanché. He compresses strongly a mixture of 40 per cent. of the peroxide, 55 per cent. of retort carbon, and 5 per cent. of gum lac resin. The depolarising mass is thus made to yield more electricity.—Action of hydracids on selenious acid, by M. Ditte.—On the decomposition of insoluble carbonates by sulphuretted hydrogen, by MM. Naudin and de Montholon.—On a new method of substitution of chlorine and bromine in organic compounds, by M. Damoiseau. This is by bringing them together in presence of animal charcoal.—On the synthesis of allantoin, by M. Grimaux.—On a new butylic glycol, by M. Nevolé.—New method of alcoometry by distillation of alcalinised spirits, by M. Maumené.—Researches on fuchsine in wines, by M. Jacquemin.—On nitralizarine, by M. Rosenstiehl.—New mineral contained in a meteorite (daubrelite), by Mr. Lawrence Smith.—On the presence of nickel in ferruginous atmospheric dusts, by M. Tissandier. This favours the idea of their cosmic origin.—Comparative micrographic analysis of atmospheric ferruginous corpuscles, and fragments detached from the surface of meteorites, by M. Tissandier.—On the physiology of the musical apparatus of the grasshopper, by M. Carlet. A special muscle distends the plaited membrane, which thus reinforces the sound. There is no tensor muscle of the timbal, and the two timbals producing the sound vibrate synchronously.—On the toxical action of methylic, cuprylic, œnanthylic, and cetylic alcohols, by MM. Dujardin, Beaumetz, and Audigé.—Anatomical characters of the blood in the anæmic, by M. Hayem. In chronic anæmia the globules are smaller, deformed, and less coloured.—Anæsthesia by the method of intravenous injections of chloral, by M. Linhart.—Lichens brought from Campbell Island, by M. Filhol, determined by M. Nylander.—On a hippopotamus with six lower incisors found in Algeria, by M. Gaudry.—On the morphology of the dental system in human races and its comparison with that of apes, by M. Lambert.

CONTENTS

THURSDAY, JULY 27, 1876

THE UNIVERSITY OF MANCHESTER[1]

III.

IN former articles we have come to the conclusion that the higher education of this country ought to be extended, and further, that this cannot be accomplished by an extension of the powers of the present Universities. The question remains how this can most properly be brought about? Let us, in the first place, refer to those projects that have already come before the public in a manner more or less definite. To begin with the American system. This is one of nearly absolute liberty. A number of men agree together to found an educational establishment, and they obtain, without any difficulty, by application to Government, the power of granting degrees. It can hardly, we think, be said that this system has worked so well in America as to encourage the hope that it may solve the educational difficulties of this country. As a rule American degrees are not highly thought of on this side the Atlantic, and we even question whether many of them command much respect on the other side. The cause of this failure is, we think, to be found in the motives which often induce men to combine together with the view of founding an educational institution. In some cases these are of the most praiseworthy character. The inhabitants of a large and influential district, while they, perhaps, differ from one another in their religious views, are yet convinced of the great importance of the higher education, and agree together to found an institution which is truly unsectarian, and which represents those good things upon which they are all agreed. But in other cases the motives of the promoters have reference not so much to the points on which they agree with the rest of the community as to those in which they differ from it; and in consequence, the institution founded partakes of a denominational character to a greater or less extent. In the one case the institution succeeds; the constituency is a large one; they possess sufficient means, and are enabled to command the services of the most eminent men—chosen only with reference to their acquirements. But, in the other case, the institution is a failure; the constituency being a limited body, is not possessed of sufficient means, and the field from which they must select their lecturers is limited by this as well as by religious considerations. They are, however, able to obtain a charter, but their degrees are of very little value.

It cannot be supposed that the British Government will ever consent to the introduction of such a system; this alternative may, therefore, be dismissed, as we see it has been (very summarily in a foot-note) by the promoters of the Owens College scheme.

The second proposal requires discussion because it appears to have commended itself to some of the leading statesmen of this country. It is the scheme for founding one great examining-board or degree-giving body for the entire country to which the various provincial colleges shall be affiliated. This scheme is alluded to in the following terms in the Owens College pamphlet:—

"Without dwelling on the experience of such systems as that till recently obtaining in France, or contrasting its results with those of systems like the German, it may be remarked that a centralisation of this description is at the present time, and must long remain, practically impossible in England, where neither are Oxford and Cambridge likely to surrender their self-government, nor public opinion to require them to do so."

It is probable that a central board of this nature while confining itself to the province of examination might yet require, unless under exceptional circumstances, the previous training implied in a college education. But even then its faults would be those of the present University of London carried out to their logical climax. At the risk of repeating ourselves we shall again state what we believe to be the faults of such an institution.

In the first place we have the paramount power—that of granting degrees possessed by a body which does not take the responsibility of itself imparting or seeing imparted by others a true education in the complete sense of that word. This education may no doubt be imparted by the various colleges, but the degree is given by a body which is virtually ignorant of the previous educational training of its candidates in a moral and social aspect.

In the next place the degree-examinations, as they are unconnected with any previous class examinations, form only a rough test of the amount of knowledge which each candidate can produce. There is absolutely no attempt to test the quality and excellence of the producing power of each candidate. In fine the moral and social training is not tested, and the intellectual training only imperfectly tested by the central board.

Thirdly, and this is a point of the utmost importance, the Calendar of the Central Board must inevitably embody only the best known and most widely diffused results of knowledge—not that which is growing and plastic, but that which has already grown and hardened into shape—the knowledge in fact of a past generation which has become sufficiently well established to be worthy of this species of canonisation. A very powerful inducement is thus offered to the professors of the various colleges to teach their pupils according to this syllabus, and a very powerful discouragement to attempt to alter it. They may be men of great originality and well qualified to extend and amend their respective spheres of knowledge, but they have no inducement to do so—their interest is to adhere to the syllabus as rigidly as a priest of the Church of Rome adheres to the syllabus of the Pope.

It is the old and time-honoured custom of killing off the righteous man of the present age in order the more effectually to garnish the sepulchres of his predecessors. Our readers are well aware that the natural philosophy course has changed its character very greatly of late years, and, that for this we are much indebted to Professors Sir W. Thomson and P. G. Tait. But could these men have done this under the system of a central board? If they had succeeded it must have been, as Galileo succeeded, against the attempt made by the ruling authorities of his day to stop his voice and strangle his originality.

The next proposal is a modification of this. It does not propose that the system of the University of London should swallow up all other systems, the impossibility of this consummation (however desirable in itself) being recognised. It rather proposes that the University of

[1] Continued from p. [illegible]

London, being a good and desirable thing of which we cannot have enough, should split itself up into two parts — a southern and a northern one—a province of Canterbury and a province of York, and that the various provincial colleges in the north should form members of the great University representing the northern province.

Our reply to this proposal is that believing the University of London to represent an incomplete system we are unwilling to contemplate its universal extension whether this be brought about by the process of absorption or by that of fission.

It is alleged by some who favour this system of grouping colleges together into one University, that a healthy principle of competition is introduced into the teaching departments of the various colleges, and they quote in favour of their views the success of the University of Cambridge in producing eminent mathematicians by this system. We shall here confine ourselves to showing that this supposed analogy is delusive. What the various colleges do, and do extremely well, is to impart a moral and social training to their pupils; but it is well known that in Cambridge the real rivalry as regards mathematical honours is not between the various colleges, but between the various private tutors. The chances are in favour of a certain tutor turning out the next senior wrangler, and accordingly the inmates of the various colleges rush off to this tutor in the hope of gaining the great prize. What this system demonstrates is rather the necessity of a thorough system of tutors in addition to that of professors, in order to secure the high proficiency of a few in any department.

Thus by a species of exhaustion, and by discussing the various alternatives suggested, we come to see that we must look to the various individual provincial colleges to become the future Universities of our country; and the only question that remains is whether Owens College be yet ripe for the change. Let us present the claims of this College to our readers in the language of the pamphlet already alluded to:—

"It remains to inquire whether Owens College may be fairly considered equal to the assumption of such a position, and whether the present period is a suitable one in its history for the College to advance such a claim. The history of the College may in any case be said to have prepared it for a University future. Owens College was founded to provide instruction 'in such branches of learning and science as were then and might be thereafter usually taught in the English Universities,' and it has uniformly sought to pursue a course and maintain a character consistent with this intention on the part of its founder. The support given to it in the district has indisputably been largely given as to an institution desiring to hold an academical level. . . . As to curricula and branches of teaching, the Senate, while unwilling to enter into details, have no hesitation in asserting their opinion that Owens College may, taken as a whole, fairly challenge comparison with any academical institutions of this and with some of other countries. We have here a ready-formed and—in essentials—complete University organisation as regards the Faculties of Arts, Science, and Medicine, together with a newly-formed School of Law. . . . The Faculty of Divinity is indeed absent; but apart from the reasons which, in Owens College as well as elsewhere, have caused its absence, it may be worth observing that the conception of a University by no means involves the necessity that it should possess chairs and grant degrees in all the faculties. This position it would be easy to prove from the history of several Universities of European fame."

This is an era of great educational activity; attempts are being made to reform our great English institutions, and a Commission is at present engaged in discussing the future of the Scotch Universities.

We are convinced that an enlightened government will best complete its efforts in this direction by giving a University Charter to Owens College, not, however, as a last and crowning concession, but rather as the first of a series of concessions, all of which, let us hope, will, when the time is ripe for them, be frankly and graciously made. Let there be no disguising the fact that Owens College is but the eldest of a large and rapidly increasing family, others of whom may, we hope, in the course of time, make their appearance before the state. It may, however, be twenty or thirty years hence before any of the recently established institutions is sufficiently ripe to receive the crowning honour of a University Charter. At present no other college can hope to present similar claims representing something like 500 day students, 800 evening students, and a very large amount of voluntary endowment. This is in truth the work of a generation.

We do not think it probable that any opposition to this movement will arise on the part of the two great English Universities. Their office is rather to lend their distinguished graduates as teachers in these new institutions, and by dint of their own practice and their great influence to see that moral, social, and even physical training are encouraged, as well as training in its merely intellectual aspect. And while they themselves may in the future be probably induced to give a greater prominence to the professorial element than they have yet done, they may in their turn induce the other Universities to encourage the tutorial element to a greater extent. In fine, these two old Universities will, whatever happens, always retain a powerful voice in the educational councils of the nation.

Nor must it be supposed that we advocate the doing away with the University of London, for whatever be the plan adopted there will always be colleges which not having attained to the rank of Universities, must look to that institution as their degree-giving body.

But the function of such an institution is to redress a hardship in the case of pupils rather than to cause and perpetuate a hardship on the part of teachers. The University of London will be heartily welcomed as a channel for imparting a degree that could not othewise be procured, but it ought not to be tolerated as a Procrustean bed for the education of the country. In fine, it was founded as the most available means of redressing a grievance, and for this very reason it is necessarily incomplete.

So long as we continue to progress—so long as colleges multiply and are not yet able to grant degrees,—so long must we retain an institution similar to the present University of London.

AGRICULTURAL WEATHER-WARNINGS IN FRANCE

AN important step has been taken by Le Verrier in the application of meteorology to practical matters by the inauguration of a system of weather-warnings specially designed for the benefit of agriculturists. The

chief features of this system of warnings are briefly sketched in a recent number of the *Bulletin Hebdomadaire* of the Scientific Association of France.

Weather-warnings intended to be useful to the agricultural interest are essentially different from those issued for the benefit of navigation. What sailors require almost exclusively to know is, the force and direction of the wind in approaching storms. On the other hand, what agriculturists require to know is a knowledge of coming rains and of thunderstorms, especially the destructive hail which often accompanies them; whilst the wind, save in rare exceptional cases, little affects them. The ability to foretell rain, the causes of which depend on conditions absolutely different in different parts of France, is unquestionably one of the most intricate problems of science, and therefore demands the closest study, wide knowledge, and sound judgment in working out its successful solution.

When, eighteen years ago, the Paris Observatory, established a system of warnings for the French Marine, the conditions for carrying them out successfully were not known. Now, however, owing to the experience acquired, the observatory is able to issue warnings of so useful a nature, that no serious storm makes its appearance in the Channel, or on the shores of the Bay of Biscay, or of the Mediterranean, which has not previously been announced to the seaports menaced by it. To-day the difficult question of agricultural warnings presents conditions of uncertainty similar to those which warnings for navigation presented in 1858. The present difficulty, therefore, is no reason for doing nothing, but only a reason for greater care and more strenuous exertion. Mistakes will necessarily be made at the first, probably numerous during the first year, seeing that there is still no precise basis on which to rest; they will, however, diminish as experience is acquired, and doubtless the time will by and by come when warnings for agriculture will be attended with a like success as now characterises warnings for navigation.

Agricultural warnings cannot, then, as in the case of warnings for navigation, be issued to the provinces by the Paris Observatory in an absolute form. It is, at this early stage, indispensable that the warnings sent to the chief places of the departments be of a general character to be supplemented and modified by local meteorological experts, who, in doing so, must be guided by their knowledge of the local peculiarities of their particular districts. This mode of procedure will furthermore lead to a thorough examination and a more exact knowledge of the meteorology of France.

The points to be more specially investigated by the departmental Meteorological Commissions at the outset, are these:—1. To follow and investigate the march of the rainfall, not only as regards quantity, but as regards the mode in which it is successively propagated from canton to canton, and from department to department, particularly when, after a season of drought, rainy weather begins to set in. 2. As regards thunderstorms (*orages*), the chief point to be attended to is that information of their first appearance be sent to the chief place of the department in which they occur, which, in its turn, will telegraph the fact to the Paris Observatory, so that the officials there may, in view of the whole circumstances, send timely warnings to those departments which appear to be threatened by the storm. 3. Since little is yet really known of hailstorms, which are often so disastrous to agriculture, it will be necessary to give instant attention to collect such data as may likely lead to some knowledge of the influence of woods, hills, and river-courses on the origin and progress of the hailstorm. 4. In connection with the late frosts of spring, which are productive of such enormous loss to agriculture, the often-alleged effect of smoke in counteracting their blighting influence will be brought to the test of experiment on a large scale, say over the whole extent of a valley. 5. Lastly, warnings relative to inundations cannot but excite the liveliest interest, in consideration of the national disasters of recent years, which might have been to a large extent lessened, if not in many cases averted altogether, if a proper system of such warnings had been in operation. To the civil and mining engineers to whom these warnings have been entrusted, the service of the agricultural warnings will necessarily lend much valuable assistance.

Agricultural weather-warnings began to be issued by the Paris Observatory, on May 1, to the three departments of Vienne, Haute-Vienne, and Puy-de-Dôme, the telegraphic authorities giving the free use of the wires in the transmission of the messages. In order to give a fair trial to this initial experiment the system will be continued daily till October 1, 1876, after which the whole matter will be submitted to a careful reconsideration.

The following example will show the method employed in carrying out the system:—On May 7 the Observatory, to show the general course of the isobarics over Europe, telegraphed that the barometer at 32° and sea-level was 29·607 inches at Palermo, 29·725 at Naples, Florence, Perpignan, and Madrid, 29·922 at Moscow, Berne, Limoges, and Bordeaux, 30·119 at Petersburg, Paris, and Lorient, 30·316 at Helsingfors, Helder, and Greencastle, and 30·512 at Hernösand, and Skudesnes. Attention was further drawn to the fact that pressure was not only high in Sweden, but that it had risen 0·393 inch, and not only low in Sicily, but had fallen 0·196 inch; and that since under this two-fold influence a polar current was flowing over Europe towards the Mediterranean, northern and easterly winds would continue to prevail, bringing with them generally clear skies and, owing to the strong sun-heat, an increase of temperature during the day. This prediction, it is needless to add, was verified by the event.

We most heartily wish every success to this bold and novel system of weather-warnings, designed for the benefit of great national interests. It may be added that it is on a sound practical knowledge of the thunderstorm, considering the term in its widest significance, that the success of these warnings will depend; and it is, therefore, singularly fortunate that in no country has so much well-directed labour and expense been bestowed on the investigation of thunderstorms as in France.

RADCLIFFE'S "VITAL MOTION"

Vital Motion as a Mode of Physical Motion. By Charles Bland Radcliffe, Doctor of Medicine, &c. (London: Macmillan and Co., 1876.)

AS there is a growing conviction of the importance of studying physiology from the side of physics, so we may be led to value more the efforts made in this line

by observers who have for long been content to work on, little cheered by recognition by the great body of physiologists, but finding their reward in honest search after truth.

Among such Dr. Radcliffe has for some years maintained the proposition that the contraction of muscle is not an acquired condition determined by the reaction of a vital property of irritability with certain stimuli, but a natural condition resumed after the removal of an electrical charge by which extension had been previously effected and maintained. In this view, for ideas related to the older terms "vitality" and "contractility," ideas related to electricity and elasticity must be substituted. Again, whereas the electrical phenomena manifested in muscle and nerve have been generally regarded —notably by Du Bois-Reymond—as phenomena of current electricity, Dr. Radcliffe has held that so far as they are functionally important, they are phenomena of static electricity, of charge and discharge.

This contention is once more set before us in the book just published under the title heading this notice, with many new arguments and with several material changes in the interpretation of facts.

In former papers Dr. Radcliffe imagined muscle and nerve to be charged with electricity after the manner of a Leyden jar; the coat (neurilemma or sarcolemma) of each fibre doing the work of a dielectric. Many serious difficulties opposed the acceptance of this notion, and now another, certainly much more accordant with the facts, is substituted. According to this later notion, the condition of each muscular or nervous fibre while alive and at rest is one and the same with that of an electromotive element, such as a Daniell's cell, in the state of open circuit. In the polarity of the electromotive element is found the explanation of the apparent existence of a current running from longitudinal to transverse or cut surface, in mutual repulsions of molecules charged with electricity, the explanation of the lengthening, after contraction, of fibres at rest; in variations of electrical charge, and in hypothetical closures of circuit the explanation of the contraction of muscle, of the return of a perfectly elastic substance to the form from which it had been distorted by the charge. Dr. Radcliffe argues that the instantaneous extra and induced currents set up at the opening and closing of circuits are important agents in discharge, and that such instantaneous currents "may be through inductive interaction greatly intensified and might prove to be very powerful" if they were not in great measure lost by being "short-circuited" within the body. As regards the mode in which circuits may be closed and nerve-muscle discharge caused by the will no clear explanation is set forth, though it is remarked that "there is no difficulty in believing that electricity, the slave of the will in this case, may have been ordered out of the way" and muscular electricity left to its own devices.

This theory of nerve-muscle charge and discharge finds important outcome in the book, having application to inhibition, rhythmical movements, rigor mortis, the influence of artificial electricity on vital motion, the work of the blood in vital motion, and many reactions of disease. The chapters relating to these are all most interesting and full of valuable suggestions, but our space will not allow of any analysis of them. A chapter on the "Electrophysics of Vital Motion" demands however a few remarks. Here are recorded observations on the electrical condition of living protoplasm, and here are made inductions to the following effect: (1) that there are no more indications of intrinsic development of electricity in vessels containing living protoplasm, of amœbæ and the like, than in vessels containing distilled water; (2) that living and lifeless bodies are equally under the sway of an electrical potential which varies from hour to hour, so that they are differently charged from hour to hour; (3) that charge will produce expansion which will be greater in aëriform bodies than in bodies which are fluid like water, and greater in these latter than in bodies which are of the nature of solids; (4) that the expansions will operate unequally in bodies which (like amœbæ) are made up unequally of portions which are more or less solid, and portions which are more or less liquid.

Amœboid movements are therefore, "as far as their electrophysics are concerned," the results of variations of electric potential. The parenthesis is important in freeing the author from the charge of forgetting that there may be other forces at work. Granting even that "electric potential" may mean the sum of the operation of a number of cosmical influences—of heat, of gravitation, of lunar and planetary perturbations; all extrinsic, all varying at any point from hour to hour—and this is granting a great deal—there are still left to be considered all the intrinsic influences which may affect molecules and determine movement, such as osmose, chemical affinity, colloid dynamis, and the like. Dr. Radcliffe's colligation is as follows: certain movements are observed to take place in small bodies composed of a mixture of semi-fluid protoplasm with more solid matter; it is conceivable that variations of electrical charge may affect these unequally and produce movement; certain variations of electrical potential are going on at the same time and in the same place in which the bits of protoplasm are moving; the bits of protoplasm do not generate or possess independent or original electricity; therefore the movements are probably produced by the variations of charge consequent on the variations of potential. Surely much more than the "hint" which the author finds in the coincidence is necessary for the establishment of wide inductions.

Fortunately the position taken with reference to the "electrophysics" of nerve and muscle rests upon a much firmer ground of observation and inference. The position is worthy of attentive study, and the argument generally commends itself to our acceptance. At least it invites further examination, and offers many possibilities of proof or trial by collateral observation. We may confidently hope to see the original and acute reasoning of the author generally acknowledged, and, better still, justified and amplified by future followers and observers. W. M. O.

FEISTMANTEL ON THE BOHEMIAN COAL BEDS

Studien in Gebiete des Kohlengebirges von Böhmen. Von Mdr. Ottokar Feistmantel. (Prag, 1874.)

AMONG the additions which extended research is every day making to the stock of our geological knowledge, none are perhaps so welcome as those which

enable us to bridge over the gaps and fill in the blanks which are unfortunately at present so numerous in the geological record. The work that has been done in this direction of late on the borderland between the Carboniferous and Permian formations promises before long to be productive of very important results. Even in so small an area as Great Britain the order of events that happened between the depositions of these two groups must have varied very much from place to place, as will appear from the following table, in which some of the more important sections are shown in a condensed form :—

North Staffordshire	South Yorkshire.	Lancashire.	Cumberland.	Ayrshire.
Permian.	Permian.	Permian.	Permian.	Permian.
POSSIBLE PASSAGE.	STRONG UNCONFORMITY.	UNCONFORMITY.	UNCONFORMITY.	UNCONFORMITY.
Upper Red* Coal-measures.	Wanting.	Upper Red* Coal-measures.	Wanting.	
	Red Rock of Rotherham.†		Whitehaven Sandstone.†	Red Sandstones.†
	UNCONFORMITY.		UNCONFORMITY.	STRONG UNCONFORMITY.
Middle Coal-measures.‡	Middle Coal-measures.‡	Middle Coal-measures.‡	Coal-measures.‡	Coal-measures.‡

* With few coals. † With coal plants. ‡ With thick coals.

Whatever be the value of the identifications ventured on in the above table, it serves at least to establish one fact; that, in the interval which it covers, there are at some spots two stratigraphical breaks, at others only one, and at others, perhaps, none at all; for in the North Staffordshire instance it is very likely that we have not a mere case of deceptive conformity, but may be a true passage. There would be nothing strange in this if we were dealing with the equivalent deposits of the whole world, or even of a large continent, but the fact that such a variety of changes went on within so small an area is worth notice, for it shows how variable were the physical conditions of what may be called the Permo-Carboniferous period; suggests to us that its oscillations, important as they are locally, may have been only local; and so paves the way for a favourable reception of any fresh discoveries that point to an absence of any break between these two formations, which are with us for the most part so sharply marked off from one another. And indeed our home experience is quite sufficient to suggest the possibility of such cases turning up; setting aside the North Staffordshire instance, which is not beyond question, the general lithological character of the Upper Coal Measures and their markedly red colour seem to point to a commencement of what may be called Permian conditions before the close of the Carboniferous period, and to establish something of a bond of union between the two formations, in spite of the unconformities which locally separate them. And when we go beyond our home circle we soon meet with cases where a passage from Carboniferous into Permian seems to exist; such, for instance, as those described by Dr. Dawson in Nova Scotia ("Quart. Journ. Geol. Soc." xxx. 209), and by Dr. Toula in Spitzbergen ("Leonhard and Geinitz' Jahrbuch," 1875, p. 225). In the monograph before us, Dr. Feistmantel treats of what he believes to be a similar instance in the coal-fields of Bohemia.

The coal-bearing beds of that country and their associated strata are broken up into a number of detached basins, and the exact correlation of the members of the different patches is, of course, open to some uncertainty; but Dr. Feistmantel thinks he can establish the following general order of succession, and three main sub-divisions :—

C. { Red sandstone, with *Araucarites Schrollianus*.
Strata, with Carboniferous plants.
Bituminous shale (Schwarte), with fish; very few indistinct traces of plants.

B. { Strata, with Carboniferous plants.
Gas-shale of Nurschaw, fish, and abundance of Carboniferous plants.
Strata of Radovenz, with Carboniferous plants.
Red sandstone, with *Araucarites*, on the north-east Bohemian Basin.

A. Strata, with Carboniferous plants.

Of these sub-divisions, A yields 232 reputed species of plants, of which 101 pass up into B; all are species usually looked upon as Carboniferous. But as we ascend in the measures, there is a gradual decrease in the plant remains, specially among the arborescent forms, which disappear in the Upper Permian, Stigmaria Ficoides alone surviving to the last. The animal remains of A are five in number and rare: they comprise a scorpion and spider, a grasshopper, and two crustaceans; all are confined to the group.

Among the beds of the groups B and C the author lays special stress on the gas-shale of Nurschaw and the Schwarte, the animal remains of which he describes as characteristic Permian forms ("exquisit permische Thierreste"), and he infers from the intercalation of these beds with others containing only Carboniferous plants, that no hard line can be drawn between the Permian and Carboniferous formations. This conclusion, to say the least, rests on somewhat slender evidence; the genera of fish quoted in his lists, on which we must mainly rely, are only seven in number, and the species are determined in four cases only; of these, one comes from a deposit the Permian age of which may be admitted, some from beds reckoned Permian by some authors and Carboniferous by others, and some genera are common to both formations. Such an amount of evidence can scarcely be accepted as conclusive. There is also a little inconsistency in the

author's final results; after having, to his own satisfaction at least, broken down the old land-marks, he proceeds to establish new ones where, according to his own showing, no hard and fast lines exist; he classes the group C as Lower Permian, A as Carboniferous, and parallels B with the Ottweil beds of the Saarbruck coal-field, which by the way are distinguished by the absence of Permian forms. It is further a matter for regret that so painstaking an observer has so little of the gift of lucid arrangement, and that he indulges so largely in what De Quincey calls the carpet-bag treatment of sentences.

But faults like these will not detract from the real value of the work; when the time comes for a rectification of boundaries on the Permo-Carboniferous frontier, the vast mass of carefully-observed facts which it furnishes will form no unimportant contribution to the body of evidence by which the question must be decided. The author may have been premature in his conclusions, but his industry and application have produced a work that will have a permanent value. A. H. G.

OUR BOOK SHELF

Holidays in Tyrol—Kufstein, Klobenstein, and Panveggio. By Walter White. (London: Chapman and Hall, 1876.)

THIS volume may be regarded as the complement to that published a good many years ago by Mr. White, "On Foot through Tyrol," in which the Brenner was the eastern limit. The present one takes us to south-east Tyrol, occasionally overstepping the boundary that divides Austria from Italy. Mr. White is a leisurely tourist, with no ambition to rival the feats of an Alpine clubbist, but with what may be called an epicurean taste for scenery of all kinds. It is this taste which keeps him to the lower heights, for from such vantage-ground alone it is found can all the varied features of the Alpine scenery be fully appreciated and enjoyed. The volume contains the results of several summer sojourns in southern Tyrol, and while its main feature is pleasant chat about the principal scenes that are presented throughout its length and breadth, there is much interesting gossip about its towns and villages, their antiquities, history, and, above all, about the people, with all sorts and conditions of whom the author came much into contact. He has the faculty of making himself at home and liked wherever he goes a pleasuring, and thus has learned much about the sentiments and ways of the people that an ordinary tourist would never discover. There is no excitement, no sensation, no hair-breadth 'scapes in the book; the chapters are very short, and the reader will feel no difficulty in laying it down at the end of any one of them; but at the same time Mr. White's pleasant chit-chat never wearies, but keeps the reader in a constant state of placidity and quiet amusement. The region described is out of the way of the ordinary tourist, but we should think Mr. White's volume ought to make it popular. The work will form a useful guide to the Southern Tyrol, and is interspersed with occasional notes on geology, which gives it a claim to be regarded as not altogether unscientific.

Angling Idylls. By G. Christopher Davies. (London: Chapman and Hall, 1876.)

MR. DAVIES is already favourably known to anglers and natural history amateurs, and many lovers of healthful and refreshing reading, by his "Mountain, Meadow, and Mere," and his "Rambles and Adventures of Our School Field Club." The present volume contains a number of charming pictures of country scenes and country life grouped round angling adventures. The Idylls—prose in form we may say—are put together with great art, which seldom makes itself felt, are simply told, and full of the unmistakable freshness of "out-of-doors," to use the author's synonym for Nature. To a jaded mind they will be found almost as refreshing as a day by a river side with rod and line is to a jaded body. Mr. Davies has a good knowledge of natural history, and knows how to observe and tell what he sees, and both the botanist and zoologist will find something to interest them in the book. Under the title of "Angling Acquaintances" he describes graphically the habits of the otter, water-vole, heron, and other animals to be found in the neighbourhood of water, and does the same in another chapter for "Waterside Plants." For lovers of the country and especially of the gentle craft the book possesses many attractions.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

Extreme Temperature of Summer

ON Saturday, July 15 last, the temperature (in the shade, four feet from the ground) at the Royal Observatory, Greenwich, rose to 93°·0; on Monday, July 17, to 94°·0; and on Saturday, July 22, to 90°·2.

Since the establishment of the Magnetical and Meteorological Observatory in the year 1840, higher readings than 94°·0 have been recorded on two occasions only; 94°·5 in 1858, June 16, which was very early in the year for so high a temperature; and 96°·6 in 1868, July 22.

The following further particulars collected from the Greenwich records may interest some of your readers.

It appears that the temperature has risen to or above 90°, out of thirty-six years, in twelve years only. The annexed list gives the particular days on which such extreme temperature was shown:—

		°			°
1842, Aug.	10	90·5	1868, July	20	90·0
1846, June	20	91·1	,, ,,	21	92·2
,, July	4	91·8	,, ,,	22	96·6
,, ,,	5	93·3	,, ,,	28	90·1
,, ,,	31	91·3	,, Aug.	5	90·5
,, Aug.	1	92·0	,, Sept.	7	92·1
1852, July	5	90·3	1869, July	22	90·9
1857, June	28	92·7	1870, June	22	90·2
1858, ,,	16	94·5	1872, July	25	90·9
1859, July	12	92·5	1874 ,,	9	92·0
,, ,,	13	92·0	,, ,,	20	91·8
,, ,,	18	93·0	1876 ,,	15	93·0
,, Aug.	25	91·3	,, ,,	17	94·0
1868, July	16	92·0	,, ,,	22	90·2

The years 1846 and 1868 were remarkable for high summer temperature; in 1846, 91°·1 was registered as early as June 20, and in 1868 92°·1, as late as Sept. 7.

Throughout the whole period of thirty-six years, the *earliest* summer maximum occurred in 1862, on May 6, and was 81°·5. The *latest* summer maximum occurred in 1875, on Aug. 16, and was 85°·4. The year 1860 was remarkable for depressed temperature; the highest summer reading having been 75°·0 only, on July 17. The year was one which agriculturists will well remember. It was in violent contrast to 1859, as the table above given shows.

Selecting the highest recorded temperature in each year, from 1841 to 1876, with the day of its occurrence, it appears, on the average of the thirty-six years, that the mean of such highest readings is 88°·3, the corresponding mean day of occurrence being July 11. WILLIAM ELLIS

Royal Observatory, Greenwich, July 24

Earthquakes in Samoa

DURING the months of December and January last there was much local seismic disturbance on the north side of the island of Savaii. Loud underground reports were heard in one particular spot near the coast. They were at irregular intervals, but

were sometimes very frequent. I could not ascertain from any of those resident in the neighbourhood the exact number in any definite time, but for several days they must have been almost hourly. The concussion was felt for a distance of four or five miles only around the focus of action; but it was so severe in the nearest village, that the people deserted their homes during its continuance.

On February 1, at 4.30 P.M., we had a very long shock of earthquake, which was felt all over the group. It lasted within a few seconds of two minutes. The oscillation was very great. The islands seemed to be in the hands of Mafui'e (the earthquake god), and he shook us with a vengeance. I took my watch in hand when I felt the first indication of an earthquake, and sat for a minute amidst the clatter of windows, lamp-glasses, and everything movable (a gentleman writing to me about it next day said his house seemed turned into a factory, with the clatter of machinery), but as it appeared to increase in severity, I deemed it prudent to go outside the house. I then noticed that the thatched roof presented the appearance of waves running rapidly across from south to north. After it was over I found two clocks—one facing north, the other south—had been stopped; one facing west was still going. In three parts of my house the plaster at the angles of walls had been broken down. Bottles were thrown down and broken. In my study, books on a shelf facing north were shaken forward; those on shelves running north and south were not affected. The screw of a copying-press, which I had used just before the earthquake, and which was standing up at the time, had been run down. I found by experiment afterwards that it required a vigorous shake with both hands for half a minute to make the screw run down.

Immediately after the earthquake I went to see if there was any oscillation of the sea. There was nothing perceptible on this—the north—side of the island. I have learned, however, from various sources that there was much oscillation on the south side. Directly after the shaking was over the reef was seen to be bare, and fish were lying exposed on it. The natives rushed to secure the fish, and while they were busy picking them up they were overtaken by a wave, which would have proved fatal to many had they not been expert swimmers. I have heard of only one life lost—a child, who was found next day jammed between two masses of growing coral. It was low water at the time, but low-lying villages were flooded by the wave.

During the following night we had four slight shocks of earthquake, but have had nothing severe since.

Upolu, Samoa, April 3 S. J. WHITMEE

P.S.—I wish to correct a misprint in my letter on "The Degeneracy of Man," which appeared in NATURE, vol. xii., p. 47. In speaking of the language of the Polynesians, I said there are many refinements, a large proportion of which are *un*known to most of the present generation. *Unknown* is, however, printed *known*, and thus the point of the illustration is lost.

Fauna and Flora of New Guinea and the Pacific Islands

I HAVE just read, with very great interest, some anthropological and zoological notes on a trip up the "Fly River" in New Guinea, by Signor D'Albertis. From these notes it appears that the "heaps of dung" which have been supposed to indicate the presence of a rhinoceros in the island, are probably the excrement of the Casuarius. Signor D'Albertis also reduces the "tracks of buffaloes" to those of wild hogs; and the fabulous bird "with a spread of wings of 16 feet" (which, in a former letter, I conjectured might have been a Casuarius, with proportionately large wings added by the imagination of the explorers under the influence of excitement), turns out to be nothing more than a *Buceros ruficollis* with a spread of wings of "4 or 5 feet."

We have, therefore, no reason for modifying our views as to the relation which the fauna of New Guinea bears to the rest of the world. Signor D'Albertis mentions a few examples only of the New Guinea flora, but some of these are specifically identical with common South Pacific Island plants.

In connection with this subject, it may be interesting to some of your readers to know that I have just entered into an arrangement with a Danish botanical collector—Mr. Fritz Jensen—under which he will start from Samoa during the present month on a voyage through the Union, Ellice, and Gilbert Islands (Atolls), to collect for me in botany and zoology. On his return to Samoa in July, he will accompany me to the Loyalty Islands, where he will make a stay of four or five weeks collecting chiefly in botany. At the close of that period Mr. Jensen will proceed to the south-east coast of New Guinea (I have some hope of accompanying him), where he will spend about two months collecting.

Mr. Jensen has been residing with me for several months working at the Samoan flora, of which I have about 700 species in my collection. By the time he completes his trip I hope the collection will be of some value as material towards the preparation of a Flora of the Pacific Islands. S. J. WHITMEE

Samoa, April 3

Optical Phenomenon

I BEG leave to send you a brief account of a striking atmospheric phenomenon which was visible in this neighbourhood on the evening of the 27th ult. Hoping that some of your usual correspondents from the North of Ireland would have sent you a notice of it before this, I delayed writing to you (see vol. xiv. p. 231).

The phenomenon consisted of a pillar of light which rose vertically from the horizon, over the spot where the sun, then set, presumably was at the time, and reached an altitude of some 8°, or perhaps more. I first saw it about 8.45 P.M., when the sun was set about a quarter of an hour, but it was, no doubt, visible earlier, probably before sunset. As the sun moved under the horizon towards the north, the pillar moved in the same direction, still retaining its vertical position, but becoming gradually lower, until at last it disappeared about 9.40 P.M., the sun being then about 6° 30′ below the horizon. The breadth of the pillar was equal to the apparent diameter of the sun. Its colour when first seen was a pale yellow, which as time advanced changed to a golden yellow, and finally to a deep red. The pillar was brighter near the horizon than at a greater altitude, and its upper end was not well defined, but gradually faded away. My son, who was with me, observed that the edges of the pillar were slightly scolloped. The sun had been clear and very hot during the day, but there was a cool air from the north-east, which became colder towards sunset. I have heard that this phenomenon was also visible at Portadown and Tynan, in the County Armagh, and at Aughnacloy in this county.

I presume there can be no doubt that the pillar consisted of a succession of images of the sun overlapping one another, but it is not easy to see how these images were produced. A nearly horizontal stratum of dense air, whose surfaces were slightly inclined to one another, with a rarer medium above and below, might form such a multiple image, by successive reflections and partial refractions at the lower surface, the sun-beam which furnished the direct or principal image to any observer, A, furnishing the second, third, &c., images to observers behind him, so to speak, and sun-beams behind the former, successively furnishing A with the images forming the upper part of the pillar.

I understand that German physicists give this phenomenon the name of Sonnensäule—sun-pillar—and that they have published some speculations as to its origin. I hope some of your readers will kindly contribute information on this subject.

"Felix qui potuit rerum cognoscere causas."

Omagh, Co. Tyrone R. V. D.

P.S.—Since writing above I have learned that the "sun-pillar" was visible over a district of the north-east of Ireland, extending from Portrush in the north to Armagh in the south, and from Bangor (Belfast Lough) on the east to Omagh on the west. I have also heard from two intelligent correspondents that it was visible at sunset, when it attained an altitude of 30°; and from two others that it presented to them the appearance of being crossed by bands, alternately of a brighter and darker shade.

Freezing Phenomenon

I HAVE waited to see whether anyone else would notice a letter that appeared in NATURE, vol. xiv. p. 191, from Mr. Power, under the above heading. Failing such notice, may I point out that the phenomenon to which he refers has already been described. Plumes produced by the crystallisation of water form the frontispiece to Dr. Tyndall's Lectures on Light (Longmans, 1873), and a description of them is given in p. 257 of that volume.

Mr. Power suggests that the brittleness of iron in cold weather may perhaps arise from somewhat similar molecular groupings occurring within the metal whilst it contracts in cooling.

One must, however, recollect that water *expands* when cooled from 39° Fahr. down to the freezing-point. To this the action of cold upon iron affords no parallel, for cold renders the metal more dense. Cold brings the atoms into closer connection; hence cold will (presumably) tend to augment the strength of their mutual attraction. H. M. ADAIR

July 18

Habits of Parasitic Crab

SOME days since I obtained in the trawl a large specimen of the common Ascidian (*A. Virginea*) and kept it alive for about a week. It contained a specimen of the small Parasitic Crab (*Pinnotheres pisum*) about the size of a threepenny piece. The crab came out every night to feed about the floor of the tank, and found lodging during the day, as I afterwards proved by dissection, in the branchial cavity of the Ascidian. The crab is commonly found in the mussel, but I was not aware before that it ever wandered abroad, or sought food except within its tenement. W. S. G.

Kenmare

THE ROWTON SIDERITE

"AN addition of exceptional interest has recently been made to the collection of meteorites in the British Museum, by the presentation, on the part of the Duke of Cleveland, of a siderite (iron meteorite) which fell on his Grace's property at Rowton, near Wellington, in Shropshire, about seven miles north of the Wrekin, on the 20th of April last. At about twenty minutes to 4 o'clock on the day mentioned, a strange rumbling noise was heard in the atmosphere, followed almost instantaneously by a startling explosion resembling a discharge of heavy artillery. There was neither lightning nor thunder, but rain was falling heavily, the sky being obscured with dark clouds for so[illegible] time both before and after the incident narrated [illegible] an hour after the explosion, Mr. George ran[illegible] of Mr. Bayley, had occasion to go to a tu[illegible] occupation adjoining the Wellington and [illegible]ton Railway, about a mile north of the Wrek[illegible] attention was attracted to a hole cut in the gr[illegible]ing the opening with a stick, Mr. Brooks disc[illegible] of metal of irregular shape which proved to [illegible]ite weighing $7\frac{3}{4}$ lbs. It had penetrated to a de[illegible]en inches, passing through four inches of soil [illegible] inches of solid clay down to the gravel—con[illegible]ce of the force of its impact with the earth. [illegible]ich has been protected for further investigati[illegible]rpendicular, and the stone appears to have fa[illegible]uth-easterly direction. Some men were at wo[illegible]t the time within a short distance, and they, together with many other people in the neighbourhood, heard the noise of the explosion."

The above account is taken from the *Wolverhampton Chronicle*, and a further notice is given in the *Birmingham Daily Post* of a meeting of the Natural History Society of Birmingham, at which meeting Mr. Brooks, accompanied by Mr. Gibbons, of Wolverhampton, and Mr. Wills, exhibited the meteorite. Mr. Wills described the circumstances attending the fall, stating that the "sound was heard as of something falling during a heavy shower of rain accompanied by a hissing and then a rumbling noise;" he further stated, "that when Mr. Brooks found the mass it was quite warm." Mr. Wills described it as "being black on the surface, and apparently covered with a scale of metallic oxides; but at the point where it impinged on the earth the oxides had been removed, and the metallic character of the mass had been revealed."

To these interesting and accurate observations, made by the gentlemen of the locality, I have the pleasure of adding that I believe it was very much owing to a resolution passed by this valuable local society, at the suggestion of the gentlemen whose names have been mentioned, to which must be added that of the well-known petrologist, Mr. Allport, of the Rev. H. W. Crosskey, and Mr. Woodward, that Mr. Ashdown, the agent of the Duke of Cleveland, took action in the matter, and obtained his Grace's assent to the meteorite being presented to the trustees of the British Museum.

On its arrival in this department it was with no small pleasure that I found the description of Mr. Wills was in all points accurate. It is, indeed, an iron meteorite, and the special interest of this statement lies in the fact that though our great collection of 311 distinct meteorites at the museum contains 104 indubitable iron meteorites, the falls of only seven of the latter were witnessed.

The collection contains eight stony meteorites that have fallen in the British Islands; but the Rowton meteorite is only the second iron meteorite known as having been found in Great Britain.

It is thus not without a keen curiosity that one inspects a freshly fallen fragment of iron just arrived from space in our own country. One hastens to ask of it what impression the action of the atmosphere has made upon its surface during its brief transit, since most of our iron meteorites have undergone long weathering in the earth. Mr. Wills, however, has given that answer. The meteorite was covered with a very thin pellicle of the jet-black magnetic oxide of iron, and only where this had been rubbed off by abrasion with the soil is the bright metallic surface of the nickeliferous iron revealed. The little meteorite has all the usual appearance of being a fragment. Irregular and somewhat angular in form, with its edges rounded, no doubt, by the fusion and removal of no inconsiderable part of its material in its encounter with the atmosphere, it presents but very slight traces of the finger-and-thumb marks which so characteristically pit the surfaces of most stone and of some iron meteorites. Furthermore, there are fissures which penetrate deeply into the iron mass and bear testimony which there can be no gainsaying to the action of disruptive forces of tremendous strength during the hot encounter of the original mass with the atmosphere, and of which one explosion, and the rumbling echoes, possibly, of others, recorded by the witnesses bear evidence. The form of one of these fissures throws instructive light on the cause of the pitted surface of meteorites. The depth to which the little mass penetrated a stubborn soil is proof of how much momentum still remained to it, partly due, no doubt, to the approximately vertical direction in which it penetrated the atmosphere, and in some degree, too, to the higher density of an iron mass as compared with one of stone, the stony meteorites rarely penetrating to so considerable a depth. This depth of penetration and the direction of the little mass in space near north to south offer close resemblance between this iron and the iron meteorite of Nedagolla, in India.

There are indications on the metallic surface of the composite crystalline structure revealed by etching iron meteorites with acids, and known as the Widmannstattean figures, the results of the separate crystallisation of different alloys, often demarked in some of their surfaces by plates of metallic phosphides.

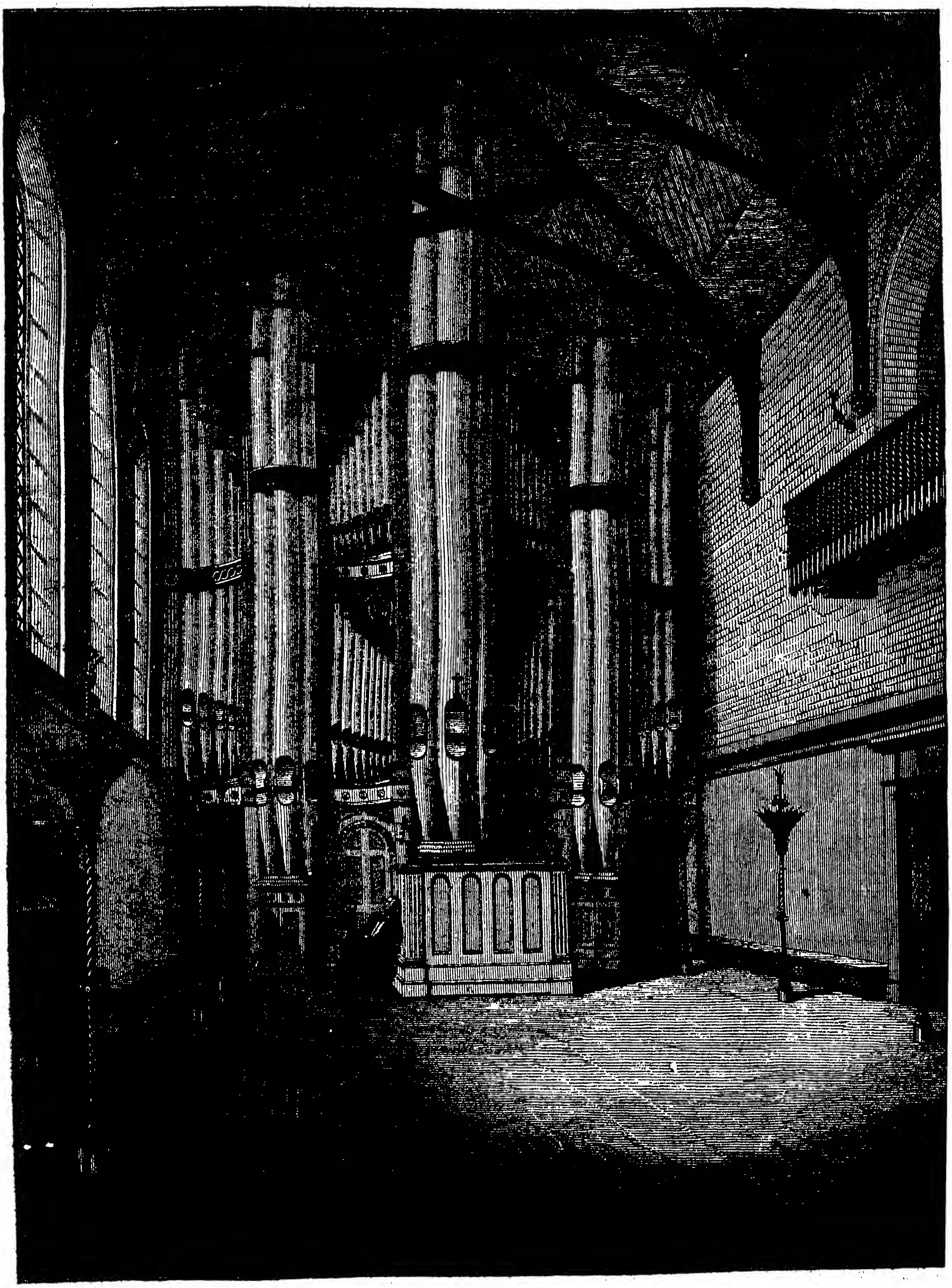
The development of this structure and the consequent determination of the particular type of iron meteorite to which the Rowton siderite belongs, as also the analysis of the iron itself, can only be carried out after a small portion of the meteorite shall have been carefully cut off by the aid of a lapidary's wheel, a process requiring in this particular case some careful precautions to prevent rust being hereafter formed and to reduce the loss of material to a minimum.

N. S. MASKELYNE

A MODERN ORGAN

IT has been hitherto chiefly on the Continent of Europe that connoisseurs in the majestic tones of the king of instruments have had to seek for a grand organ. Though London, the mistress of the world for wealth and magnitude, has churches and chapels innumerable, and organs by hundreds, scarcely one is of sufficient importance or merit to attract the attention of a stranger. Church organs are, as a rule, small, and built without individuality or character of tone, and generally so placed in the building as to effectually mar in acoustical effect any special merit they might otherwise possess. Of the two or three instruments that have any pretensions to magnitude to which the public has access—at the Albert Hall and the Alexandra and Crystal Palaces, no very lasting impression remains upon the audience beyond that of noise and a distressingly harsh volume of sound, utterly devoid of musical depth and grandeur of tone, and quite different from the pleasing reminiscences that dwell upon the memory from hearing some of their more musical Continental rivals at Haarlem, Freiburg, or Lucerne. To successfully construct a large organ is a work of exceeding difficulty, for not only does size greatly complicate the mechanical action, but the proper distribution and apportionment of the wind to each stop, and the harmonious blending of the whole together in the full organ, demands great knowledge and skill upon the part of the builder. It is for these reasons that very few large organs rise beyond mediocrity, or are noted for the beauty of their tone or the perfection of their mechanism. The great advance in the general taste for organ music within the last few years has necessitated an improvement in the mechanical construction of the organ, so as to enable the performer rapidly to command the entire resources of the instrument at will, and give him absolute control over the various sound-combinations and tone-colouring of the different stops, according as they are brought on or off by means of the appliances placed at his disposal.

We give a brief description of the very remarkable organ recently erected at Primrose Hill Road, Regent's Park, remarkable alike for its size, being larger than the great Haarlem organ, its beauty, richness, and grandeur of tone, and the completeness of its mechanism. At present this superb instrument is almost entirely unknown to the musical section of the public. The annexed illustration shows that this organ is one of the first magnitude. It possesses what is known as a 32-feet metal speaking front, with a corresponding weight of tone throughout the pedal organ, and several organs which together constitute the instrument, and give it its place in the scale of magnitude as compared with the more celebrated of the continental instruments. The instrument in question has several novelties not to be found in other organs. It possesses seven distinct organs: pedal, great, choir, swell, solo, echo, and carillon organs, each extending the full compass of 5 octaves (61 notes) with the exception of pedal organ, 30 notes. These various organs are under the control of the performer by means of four manual key-boards, which together comprise sixty-seven speaking-registers, and these are combined together with various acoustical effects by means of thirty-one mechanical movements, making a grand total of ninety-eight sound-controlling registers, worked by hand and foot. The entire mechanical action necessary to control these registers and accessory movements is carried out by a novel application of atmospheric vacuum pressure. Two distinct systems of main air trunks extend throughout the interior of the organ in connection with the wind arrangements situated in the basement of the building. One of these systems of trunks is for the purpose of conveying the wind at different pressures to the sound boards of the various organs in connection with the musical speech of the several groups of pipes. Thus the wind supplied to the solo organ, swell reeds, and large pedal reeds, is the heaviest pressure employed in the instrument for producing the musical intonation of the pipes, namely, 6 inches. The wind pressure to the sound-boards of the great organ and swell flue work is 4 inches, that of the choir organ 2 inches, and the pressure of wind is again reduced in connection with the sound-boards of the echo organ to half an inch, the lightest wind upon which any organ has ever yet been attempted to be voiced. This question of wind pressure as affecting the voicing and musical intonation of the pipes of an organ is one of great importance, and upon the skilful adjustment to the size, diameter, and materials of which the pipes are constructed, depends the sweetness and quality of the musical tones produced. In the organ under notice the very light pressure of wind adopted affords an example for careful study and examination First, for the mellow sweetness and beauty of tone produced; secondly, for the promptness of speech obtained, as rapid as the articulation of a pianoforte string; and thirdly, for the immense volume of sound and power that can be produced from these light pressures, the combined effect of the full organ rivalling almost the artillery of heaven as thunder crash after crash bursts upon the ear. Much of the harsh unmusical tone of modern organs arises from this desire to obtain power at the expense of music by the employment of an over-pressure of wind. That age is not requisite to mellow an organ is demonstrated by listening to the diapasons and foundation stops of the Primrose Hill organ, which have all that ripe and fascinating sweetness of tone characteristic of Silbermann's finest instruments. These light pressures of wind constitute a remarkable feature in the construction of so large an organ. The second series of air trunks which permeate the interior of the instrument are in connection with two large vacuum exhaust bellows which, being continually actuated by the steam-engine used for blowing, maintain a constant vacuum pressure throughout the entire system of trunks, so that at any part of the organ an available mechanical power (that of the pressure of the atmosphere 15 lbs. to the square inch of surface) is at hand to be employed for the multitude of purposes required in a large instrument. To be obliged to have recourse to the old system of wooden rods, trackers, levers, and squares in endless complications, would have so weighted and impeded the action of the organ as greatly to destroy its musical capabilities. In most of the large organs constructed both at home and abroad, many parts of the mechanism are far from being so perfect as to leave no room for anything further to be desired, and the executant upon the instrument rarely is able to portray as rapidly his musical creations mechanically at his finger-ends as those creations in tone-colour flash through his mind. By the introduction of atmospheric vacuum pressure as the "motor" power, there is no complication of mechanical parts; an almost endless system of tubes being carried from the key-board registers to the sound-board sliders of the several organs. These tubes are in connection with powerful exhaust bellows and vacuum power-bellows attached to the sliders, so that any required stop is brought on or off instantaneously, however distant from the key-board. These tubes may be bent and twisted round corners in any direction, and the parts of the organ most difficult of access easily reached. No mechanical force is therefore necessary to be exerted at the keyboards, the mere touch of a key, register, pedal, or finger-button, at once brings its special tube and exhaust arrangement into operation. The wonderful completeness of this system of vacuum-tube action is beautifully illustrated by means of the echo organ—a complete instrument of 16 feet tone, situated some 100 feet from the key-boards of the great organ—and supported on corbels against an opposite wall at an elevation of some 30



View of "The Great Organ" recently erected at the Hall, Primrose Hill, London.

feet from the floor. The action of this organ is electrical, that is, there is no mechanical communication between the performer at the key-board 100 feet distant and the organ pallets which admit the wind to the pipes, save a small rope of 61 insulated copper wires—one wire for each note of the five octaves. The various stops of this distant organ are likewise controlled without mechanism—a series of vacuum tubes alone extending from the registers at the great organ to the sliders of the echo organ—which are thus brought on or off at the will of the performer by a silent action—at once accurate and instantaneous in its manipulation. The effect of this echo organ, is that of a large organ heard at a great distance. Without the aid of the electric action, and vacuum pressure, such an organ could not have been designed. Mechanical action would never have successfully developed such effects at such an extended distance.

The same vacuum system is also applied to the various pneumatic lever arrangements interposed between the keys at the consol and the wind-valves at the sound-boards to relieve the performer from any undue mechanical pressure that might detract from the promptness of repetition and delicacy of touch of the key action, the keyboards being thus rendered as light as that of a grand pianoforte. Such results cannot be obtained so efficiently by the employment of compressed air for a pneumatic power action; compressed air will always prove to be more or less sluggish, a "creeping on" and "creeping off" movement being the result, besides a limit to the aggregate of the instantaneous power that is at command.

The pneumatic drawstop action of the St. George's Hall organ, Liverpool, is a fair illustration of the defects of the compressed air system. In the Primrose Hill organ upwards of forty registers can be simultaneously drawn on or shut off as easily and with the same precision as though only a single stop were drawn. The consol or keyboards of this organ, as will be seen by the engraving, are reversed, that is, the performer faces the audience, the organ being behind, and the echo organ opposite him. The lowest keyboard manual is the "great organ;" the next, or second from the bottom, the "choir organ;" the third in the series the "swell organ;" and the fourth, or upper row of keys, the "solo organ." By a simple mechanical arrangement this fourth keyboard is also used for the electric "echo organ," and also for the carillon, or "bell" organ, otherwise it would have been necessary to have introduced a fifth set of keys, an arrangement at all times objectionable from the increased complications imposed upon the performer. The touch of the carillon organ on the fourth row of keys is expressive like that of the pianoforte key, and gradations of tone and distance are therefore capable of being expressed upon the bells.

In this organ the French ventil system of shutting off or bringing on the wind to a complete family or group of stops by the depression of a pedal has not been adopted, such a system being found inadequate to effect rapidly the almost endless combinations that such a large instrument has at command, the pneumatic combination foot pedals and finger buttons at the keyboards being introduced as a more convenient form of manipulating the registers.

The wind supply of this gigantic organ is furnished from four large reservoirs in the basement, which again supply seventeen reservoirs in connection with the various sound-boards of the organ; the vertical feeders for producing the wind to these reservoirs, as well as for creating the vacuum pressure, are set in motion by an eleven horse-power steam-engine. The wind supply is so ample, that with the power of the full organ it is impossible to exhaust or create unsteadiness in the wind; few organs are properly constructed in this important respect. [illegible] automatic lever engine for regulating the motion and the supply of wind from the vertical feeders into the reservoirs according to the demand of the organ, is [illegible] between the steam-engine and the wind reservoirs, so that the regulation of the wind supply is independent of the speed of the engine, which remains constant. This instrument, which occupied three years in its construction, and was opened in January, 1876, has been erected under the personal supervision of Mr. W. T. Best, of Liverpool, by the eminent organ builders Messrs. Bryceson Brothers, and Morten, of London, for Mr. Nath. J. Holmes, and is erected in the large music-room at the Hall, Primrose Hill Road, built expressly to receive it. The instrument, which stands 50 feet high, 30 feet broad, and 30 feet deep, suffered severe injury from the effects of concussion, in common with the building in which it is erected, at the time of the disastrous explosion of gunpowder on the Regent's Park Canal, near Primrose Hill.

PALÆONTOLOGY AND THE DOCTRINE OF DESCENT

"THE great biological question of the day is the problem of evolution; but geologists, as Kant says, are the archæologists of nature, and the sole direct and irrefragable evidence of the method whereby living things have become what they are is to be sought among fossil remains." Such were the words spoken by Prof. Huxley on a recent occasion, when receiving from the hands of the president of the Geological Society the Wollaston medal; and the assembled geologists, calling to mind his masterly review of the whole question in his address to them in 1870, rejoiced to hear their former president expressing the hope that much of his future labour would be concentrated on this all-important palæontological problem.

The discoveries of such abundant mammalian remains in the Tertiary deposits of the Western territories of America have added much valuable material to that already obtained from the Paris basin, the Sivalik Hills, Pikermi, and many other districts; and we may look forward with confidence to the labours of vertebrate palæontologists for bringing to light many interesting relations between the members of the existing fauna and their ancestral representatives in the later geological periods.

In the meanwhile it may not be uninteresting to point out that among the invertebrata similar evidences of the transitions between life-forms which at first sight appear to constitute perfectly distinct groups, are constantly being detected by palæontologists. No opportunity for doing this more effectively could possibly be desired than that which is afforded by the publication of a most suggestive and valuable monograph by the distinguished palæontologist of Vienna, Dr. Neumayr, in conjunction with M. Paul of the Austrian Geological Survey, a work which has just apppeared in the seventh volume of the *Abhandlungen der k. k. geologischen Reichsanstalt*. The title of this memoir is "Die Congerien- und Paludinen-schichten Slavoniens und deren Faunen; ein Beitrag zur Descendenz-Theorie;" and its authors have earned the thanks alike of geologists and biologists, for the important evidence on the great question of evolution which has been the fruit of their patient researches.

The geological formation which has afforded the evidence in question is the grand series of lacustrine beds, forming the highest portion of the magnificently developed Tertiaries of Eastern Europe, and which constitute the approximate equivalent, in all probability, of our Pliocene; and it is a district on the southern limits of the Austrian Empire, the border-land of that area to which the attention of all Europe has been so painfully drawn for many months past, that has furnished the valuable sections of this formation and the abundant fossil remains, the

discussion of which is the object of the memoir we are noticing. On the northern bank of the Save there rises from the "diluvium" of the vast Hungarian plains an "island" composed of various crystalline, Triassic, and Tertiary rocks, and on the southern side of this tract of older deposits and upheaved along its flanks, between the towns of Alt Gradiska and Turkish Brod, stretches a vast mass of strata, constituting probably the most magnificent representative of the latest stage of the Tertiary period which geologists have as yet had the good fortune to discover.

The strata in question consist of sands and clays, with numerous beds of lignite, and it is to the value of the latter as fuel that we are indebted for those excavations which have afforded such excellent opportunities for studying the successive series of faunas of the formation. The whole of the beds appear to be of lacustrine origin, and have been accumulated, doubtless through the long-continued subsidence of the area, to the enormous thickness of about 2,000 feet; the lower division of the strata known as the "Congerien-Schichten," appears to have been formed under brackish-water conditions, but their upper and by far their thickest portion was certainly accumulated in fresh water. This upper fresh-water series, the "Paludinen-Schichten," is divided by our authors into three principal groups, comprising eight zones, each of which exhibits a well-marked and characteristic fauna.

The group of shells which affords the most interesting evidence of the origin of new forms through descent with modification is that of the genus *Vivipara* or *Paludina*, which occurs in prodigious abundance throughout the whole series of fresh water strata. We shall not, of course, attempt in this place to enter into any details concerning the forty distinct *forms* of this genus (Dr. Neumayr very properly hesitates to call them all *species*) which are named and described in this monograph, and between which, as the authors show, so many connecting links, clearly illustrating the mode of derivation of the newer from the older types, have been detected. On the minds of those who carefully examine the admirably engraved figures given in the plates accompanying this valuable memoir, or still better the very large series of specimens from among which the subjects of these figures are selected, and which are now in the museum of the Reichsanstalt of Vienna, but little doubt will, we suspect, remain that the authors have fully made out their case, and have demonstrated that, beyond all controversy, the species with highly complicated ornamentation were variously derived by descent—the lines of which are in most cases perfectly clear and obvious—from the simple and unornamented *Vivipara achatinoides* of the Congerien-Schichten. It is interesting to notice that a large portion of these unquestionably derived forms depart so widely from the type of the genus *Vivipara* that they have been separated on so high an authority as that of Sandberger, as a new genus, under the name of *Tulotoma*. And hence we are led to the conclusion that a vast number of forms, certainly exhibiting specific distinctions, and, according to some naturalists, differences even entitled to be regarded of generic value, have all a common ancestry.

The vast Tertiary lake-basins of Eastern Europe, in which similar conditions were maintained during such an enormous period, and in which such an unbroken sequence of deposits was accumulated, offer, of course, a particularly favourable opportunity for investigating the relations existing between successive life forms. The disturbing elements, arising from rapid variations in physical conditions attended with the circumstance of the immigration of forms from other areas, and the consequent retreat of the older fauna, the evidence of which is so constantly detected in the case of geological formations of marine origin, are here to a very great extent eliminated; and hence we are able to trace with marvellous precision the exact pedigree of an immense number of diverse forms.

We may, however, be permitted to add that much of the failure in recognising the undoubted ancestral relationships which exist between many marine invertebrate fossil forms, appears to arise either from prejudice on the part of the observers, or from that unfortunate divorce between the work of the physical geologist and the palæontologist, which, in this country at least, tends to confine the former entirely to the field, and the latter as absolutely to the museum. In no way can the admirable results which may be expected to ensue from the combined study of the physical and palæontological characteristics of a formation be better exemplified than by an appeal to the publications of the Geological Reichsanstalt of Vienna. In the same volume of the *Abhandlungen*, which contains the valuable memoir to which we have alluded in the former part of this article, is published a second instalment of Dr. E. Mojsisovics' splendid monograph, "Die Mollusken-Faunen der Zlambach und Hallstätter-Schichten," in which the wonderfully-varied molluscan forms of the Alpine Trias are so admirably described, their derivation traced, and their relations to the Palæozoic and Mesozoic types clearly indicated. While the study of such exceptionally well-preserved faunas as those we have alluded to cannot but impress us with that incompleteness which is undoubtedly the usual characteristic of "the geological record," it nevertheless leads us to entertain the hope, and even to express the certainty, that in the hands of the palæontologist lies the key to that mystery which at present envelopes the laws that have governed the appearance of the successive forms of life.

J. W. JUDD

PRIZES OFFERED BY THE DUTCH SOCIETY OF SCIENCES

THE following subjects for prizes have been proposed by the Dutch Society of Sciences, Haarlem.

1. To make a complete experimental study of the question whether a Daniell element can decompose water, and to submit to a critical examination the theories according to which it does or does not possess this power.

2. What are the meteorological and magnetic phenomena which there are sufficient reasons for believing to be connected with sun-spots?

3 It seems to result from certain experiments of M. Bunsen (*Ann. der Chem. und Pharm.* lxxxv. p. 137, *et. seq.*, 1863), that when mixtures of hydrogen and carbonic oxide are inflamed in a eudiometer with a quantity of oxygen insufficient for complete combustion, there always remains a part of the two combustible gases, and that the quantities of water and of carbonic dioxide which are formed have the relation to each other of simple multiples of their molecular weights. The same will hold good for the quantities of carbonic monoxide and carbonic dioxide which are generated by the combustion of cyanogen by means of a limited quantity of oxygen. The Society requires that these experiments be repeated on a more extended scale, with gaseous mixtures of very diverse composition, and by varying considerably the proportions of the constituents.

4. The researches of Mr. Lockyer concerning the difference of the spectral lines which calcium gives by means of electricity at different temperatures, have excited in a high degree the interest of the Society which requires that these important researches be extended to other elements.

5. Give a critical *résumé* of the observations and experiments concerning the existence of Bacteria in the contagious diseases of man, followed by original researches on the same question, studied in one or more of these diseases.

6, The society requires a simple instrument by which temperatures above 350° C. may be measured in degrees of the air-thermometer.

7. Make researches on the influence which the different colours of the spectrum exercise on the life of the lower animals.

OUR ASTRONOMICAL COLUMN

DE VICO'S COMET OF SHORT PERIOD.—According to the limits for the value of the mean diurnal motion of this comet when it was last observed, in 1844, assigned by Prof. Brünnow from his later researches, the results of which are published in the *Astronomical Notices* issued during his direction of the Observatory of Ann Arbor, Michigan, it would appear that in the absence of any great perturbation a perihelion passage may be expected to occur some time in the twelve months following the beginning of December next, and those who occupy themselves in searching for comets might advantageously institute during that interval a systematic examination of the parts of the sky in which the comet must be situate according to different suppositions as to the date of arrival at perihelion.

The comet of De Vico is most favourably placed for observation when the perihelion falls about Sept. 4, in which case it approaches the earth within 0·2 of our mean distance from the sun. It follows therefore that in 1844, when the comet was in perihelion about midnight on Sept. 2, the conditions were nearly at their best. The comet was detected at Rome on August 22, and was observed by O. Struve at Pulkowa, till Dec. 31. In a masterly discussion by Prof. Brunnow, entitled *Mémoire sur la Comète Elliptique de De Vico*, which gained the prize offered by the Royal Institute of the Netherlands, the elements for 1844 are determined by the most refined methods, and are accurately perturbed not only to the next return in 1850, when from the position of the comet in the heavens there appeared no possibility of its being observed, but to the second return in 1855, when the perihelion is fixed to August 6, ephemerides to facilitate its re-discovery being added to the memoir. From whatever cause, however, the comet was not found in 1855.

The mean motion finally adopted in Brunnow's memoir for the perihelion passage in 1844 corresponds to a revolution of 1996·3 days. In the subsequent calculations to which reference is made in the Ann Arbor *Notices*, he finds a value which diminishes the period of revolution to 1994·0 days, and, as regards the probable error of this determination of the amount of daily sidereal motion (649″·936), he shows that his work rather tends to exclude a greater one than 2″. Nevertheless he particularly insists that too much stress should not be placed on this indication, pointing out the possible influence of a small but variable error in the sun's places, which were taken from Carlini's Tables, and likewise the effect of variation in the form of the comet during the time it was under observation, upon the deduced positions. It does not appear upon what authority Brunnow assumes the reality of material changes in the aspect of the comet. The writer of these lines had the comet under frequent observations particularly after the middle of October, when, as it was receding from the earth, variation of figure by influencing the judgment as to the point to be observed would have had most effect, and well remembers that even to the last week in December, when it had become little more than a glimpse-object with 7 inches aperture, there was still an extremely minute nuclear point, which, with a larger instrument, would admit of very accurate bisection. The comparison with the Pulkowa observations (*Mémoire*, p. 29) affords no evidence of any effect of the kind suggested by Brunnow.

Now there is one point, hitherto it is believed unnoticed in the astronomical periodicals, which bears upon the non-recovery of the comet of late years. Brünnow drew attention to the close approximation of the orbit of De Vico's comet to the orbit of the planet Mars at two points falling near 42° and 287° of heliocentric longitude. If we adopt his later elements, we find that at the first point the distance between the two orbits was 0·0226, and at the latter point 0·0104, distances which, as Brunnow remarks, are "assez petites, pour produire des perturbations sensibles, quelque petite que soit d'ailleurs la masse de la planète perturbatrice;" and it is to be borne in mind that the above distances, small as they are, may have been diminished very sensibly by the effect of accumulated perturbation since 1855, beyond which we have no calculation of the effects of planetary attraction. If the mean diurnal motion in 1855 were as large as 652″·05, a value considerably within Brunnow's suggested limits, the comet might have come into extremely close proximity to Mars at the end of August, 1866, in about 42°·3 heliocentric longitude.

While, however, the above appears a certainly possible contingency, it is not, perhaps, necessary to suppose the existence of any unusual cause for the non recovery of the comet. As occurs with most of these bodies, there are certain periods of the year at which observation would be impracticable; in the case of the comet of De Vico, this disadvantageous period would fall chiefly in the first four months of the year, the perihelion point then falling on the opposite side of the sun to the earth, and the inclination of orbit being very small. How far this may bear upon the question may be judged from the fact of there being no record of this comet having been observed between the year 1678, when Le Verrier identifies it with the comet discovered by Lahire at Paris, and the re-appearance in 1844; and it is worthy of remark that the perihelion passage in 1678 fell only one week earlier than the date which may be considered the most favourable.

A more particular examination of the comet's track in the heavens at different periods of the year is deferred for a future column.

MIRA CETI.—The minimum for 1876, calculated by Argelander's formula of sines from the epoch of Schonfeld's last catalogue, *i.e.*, by applying the same perturbations to minimum as to maximum, falls September 1·2, and may therefore be observed under favourable circumstances. There are comparatively few good determinations of the minima epochs, or of the magnitude of the star at these times, which will justify a hint that it should be watched on this occasion.

RESOURCES OF SERVIA AND BOSNIA

THE small extent of country upon which the eyes of Europe are now centred lies too far out of the beaten tracks of travellers for much to be generally known as to its capabilities or natural resources; nevertheless the country is described in the few existing works as being very fertile, and the soil might be made much more productive were it not for the idle and dirty habits of the people. In these days of "Special Correspondents," the breaking out of a war, even in the remotest parts of the world, is a signal for the dispatch of men of observation, whose duty it is to chronicle the movements of the opposing parties, and, in some cases—we wish it were more often so—to give us glimpses into the habits of the people and the natural features of the country. Thus, we may in the course of a few weeks learn from the public press more about these matters in connection with the small districts now at war with Turkey than we are able to gain from books. The mines of Servia and the forests of Bosnia are two of the principal sources of revenue to the countries. Both iron and copper can be obtained, not only in large quantities, but also of excellent quality. The best Bosnian iron resembles that of Sweden, and is largely used in the manufactories of Gratz, in Styria; quantities also pass into Dalmatia and Servia. These mines are mostly worked by English companies under concessions from the authorities. In the forests are several species of oak, including the evergreen, or Holm Oak (*Quercus Ilex*), the Turkey Oak (*Q. Cerris*), *Q. Ægilops*, *Q. infectoria*, and others. The

first two are of little or no use economically, except perhaps, for their woods, and these are not so highly valued as those of other species; the *Q. Ægilops*, however, which produces large acorns seated in very large cups, is valuable for the sake of these cups, which contain a large quantity of tannin, and are extensively used by tanners and dyers, being imported to a considerable extent from the Levant under the name of Valonia. *Q. infectoria* is also a valuable species, producing, most abundantly, the large shining brown galls known as Mecca galls, used for dyeing purposes, in the manufacture of ink, and in the preparation of tannic and gallic acids. The principal value of the oaks in Bosnia seems to be in their timber, the staple use of which is in the manufacture of staves for casks, immense quantities of which are exported. Amongst the pines occurring in the forests are *Pinus Laricio*, *P. maritima*, *P. halepensis*, and others, as well as the Scots Fir, *P. sylvestris*. Besides these are other forest trees of more or less value, so that if the forests were properly worked, they would not fail to prove of great value. At present, however, the right of cutting timber is held chiefly by foreign speculators, and has proved a source of wealth to many Austrians and Frenchmen who have embarked in it.

One of the most valuable products, both of Bosnia and Servia, as at present developed, lies in their plum crops, many of the peasantry depending entirely on these fruits as the means of subsistence through a great part of the year. The plums, after being gathered, are mostly dried in the form of prunes, the secret or art of drying being known only to themselves. The Bosnian plums are considered of a better quality than those either from Servia, Croatia, or Austria. A quantity of spirit is likewise prepared from these fruits. Amongst other vegetable products of the country may be included tobacco, potatoes, flax, hemp, walnuts; and amongst cereals, wheat, maize, barley, oats, rye, millet, &c. Wheat and maize are the principal food plants consumed in the country, some of the other products being exported in comparatively large quantities.

A notice of the resources of Servia, however brief, could not be closed without a reference to the remarkable traffic in pigs, the value of which amounts to nearly one-half of that of the entire exports of the country. In one year 472,700 of these animals were exported from Servia, the bulk of which are fattened at Steinbruch, near Pesth, in Hungary, where more than 500,000 pigs from various parts are fattened yearly. Their value is not on account of their flesh as an article of food, but exclusively for melting down for their fat.

From these notes it will be seen that in Servia and Bosnia are numerous undeveloped natural resources, and, under a different system than that which now prevails, both forests and mines might be made much more productive.

J. R. J.

NOTES

The French Association for the Advancement of Science will meet this year at Clermont-Ferrand. This meeting will possess unusual interest, as the Puy-de-Dôme Observatory will be opened for inspection for the first time to visitors. That establishment is now in operation, and the results of observations taken are regularly registered in the *Bulletin de l'Observatoire*. A large subvention has been voted by the Municipal Council of Clermont and by the Puy-de-Dôme department, a local Committee has been appointed for the reception of visitors, and the arrangement of excursions to the surrounding mountains, Mont Dore, and others. The session will be presided over by M. Dumas.

The Council of the Yorkshire College of Science have added another subject to those taught at the College, by providing for a chair of Civil and Mechanical Engineering. They have elected as Professor, Mr. George Frederick Armstrong, M.A., F.G.S., Asso. Inst. C.E., who has for the past five years occupied the chair of Civil Engineering and Applied Mechanics in the McGill University, Montreal.

The French Minister of Public Instruction, *L'Explorateur* informs us, is occupied with the organisation of scientific missions having for their object the study of certain determinate points in philology, geography, history, and commerce, both in France and the rest of Europe, as well as in Africa and America. The number of these missions will be thirty-two; twenty-eight are already completely organised. Nine missions will be occupied with natural history; one of these will investigate specially the fauna and flora of Switzerland; four will undertake researches connected with medicine and hygiene, four others dealing with languages; twelve will be occupied with the history and special investigations relative to peoples which have disappeared, or nearly so, as well as to their remaining monuments. Finally, three missions will undertake astronomical and meteorological investigations.

The following are the numbers of visitors to the Loan Collection of Scientific Apparatus during the week ending July 22:—Monday, 2,275; Tuesday, 2,466; Wednesday, 486; Thursday, 393; Friday, 441; Saturday, 2,770; total, 8,831. During the present week 12 demonstrations were given on Monday, 12 on Tuesday, 5 on Wednesday; 7 are to be given to-day, 5 to-morrow; and 4 on Saturday, including the daily lectures to science teachers.

M. Schutzenberger has been appointed to succeed the late M. Balard in the Chair of Chemistry in the Collége de France.

An International Congress of Geography will be held at Brussels on Sept. 11. All the governments have been invited by the King of the Belgians to send delegates. The object of this Congress is the organisation of an international scientific expedition to Central Africa.

The "Report of the Radcliffe Observer" for the year ending June 30 last, shows that the work of the Observatory has been carried on with efficiency. In all departments much good work has been done, and it is satisfactory to notice that the "Third Radcliffe Catalogue" has been commenced at last. Mr. Main's observations confirm those of other observers with regard to the recent remarkable absence of spots from the sun.

A letter in the current number of the *Planters' Gazette* draws attention to the continued importation and sale of filth, under the name of tea, which trade is carried on under the eyes, so to speak, of the Government officials themselves. The writers say:—"We have recently seen samples of mouldy refuse and dust which is now being retailed at the east-end at the rate of 2 oz. for 1*d*., or equal to 8*d*. per pound, duty paid. We submitted the samples to an official occupying a responsible position in the city, but were informed that the Government could not interfere, as the rubbish had passed the Custom House. Three or four hundred packages of 'Maloo mixture' have been delivered from one of the up-town warehouses during the fortnight for shipment, we understand, to Rotterdam."

In connection with the recent *Thunderer* disaster, we would draw attention to a lecture given to the Engineering Class in the University of Glasgow by Prof. James Thomson, "On the Principles of estimating Safety and Danger in Structures in respect to their Sufficiency in Strength." It is published by Maclehose of Glasgow.

A French barrister who died recently left by his will two large houses to the city of Paris, for the purpose of establishing a new municipal college. The houses have been sold for the sum

of 1,600,000 francs, and the municipal council is now busy carrying out the conditions of the will. It is said many improvements will be carried out in the new establishment.

A STATUE has been erected at Bayeux (Calvados) to M. de Caumont, who originated forty-two years ago the Congress of the French learned societies of the provinces. This year the meeting will take place at Autun (Haute-Marne) in the beginning of September.

LIEUT. CHRISTIE, R.E., writing to us from Madras with regard to the use of selenium in telegraphy, says that if we could do away with the man (or woman) signaller, and substitute a commutator actuated by a current of electricity generated by the action of light upon a piece of selenium, we should (supposing the sensitiveness of the selenium to be adequate) have a combination capable of enormously increased rapidity. The message to be transmitted would be first set up (by mechanical means) in the Morse character, in long and short *slits* in an opaque screen; and this perforated screen being passed rapidly between the selenium and a source of light, the currents of electricity would be generated which are required for actuating the commutator. The possibility of such a combination depends on the sensitiveness of selenium to the influence of light. Assuming the combination to be possible, the rapidity of signalling would seem to be limited only by either the mechanical conditions of the commutator (or relay), or the power of the printing instrument at the receiving station,

EVERYONE will be glad to hear of Mr. Stanley's safety, and of the success of the African Expedition, of which he is head. From the brief notice in yesterday's *Telegraph*, we learn that several despatches have been received from Mr. Stanley, the last dated April 24, 1876, from Ubagwe, in Unyamwezi, within fifteen days of Ujiji. Mr. Stanley further explored the Victoria Nyanza, and inflicted one of his regrettable "severe punishments" upon the people of Bambireh, for a former attack. The district between Victoria and Abert Lakes was explored, and a "strange tribe of pale-faced people" was met with in the "cold uplands" of a remarkable mountain, Gambaragara. He returned to Uganda, whence he set out to Ujiji, exploring the Kagera River, Speke's "Lake Windermere," and the hot springs of Karagwe. We regret to notice from a *Daily News* telegram that the Italian African Expedition has been badly treated by the "Emir of Zeila."

THE number of denizens of the Southport Aquarium has been lately increased by the birth of no less than 1,000 sea-horses in one of the tanks.

IN Prof. Loomis's "Contributions to Meteorology," fifth paper, just published in the *American Journal of Science and Arts*, an important point suggested is that when barometers are low and temperatures high in Iceland, barometers are high and temperatures low in Central Europe, and similarly that a like relation exists between the barometers and temperatures of the Aleutian Islands and those of the United States—the influence in both cases being most decided during the cold months of the year. The idea here thrown out is deserving of a thorough investigation by the facts of observation owing to its important bearings on weather-forecasting. It is shown in the same paper that, in the course of storms, the amount of rainfall is least when the pressure at the centre of the storm is increasing, or when the storm is diminishing in intensity; and the amount of rainfall is greatest when the pressure at the centre of the storm is decreasing, or when the storm is increasing in intensity, the effect being also most decided during the colder months of the year.

THE French Alpine Club will hold a General Congress at Annecy on August 13, 14, and 15. All the sections of the French Alpine Club will be present, and the English, Italian, and Swiss Alpine Clubs are expected to send a large number of representatives.

THE Vienna earthquake, to which we referred last week, occurred on July 17 at 1.22 P.M. The principal seat of the commotion was Scheibbs, a small country place forty miles west of Vienna; almost every house in Scheibbs has been damaged. The area of the commotion was very large, equal to about two-thirds of England. It reached Austria proper, Moravia, part of Bohemia, and Hungary. The last earthquake in Vienna was on January 3, 1873. Fifteen instances of earthquake have been recorded in Vienna from the beginning of the thirteenth to the end of the eighteenth century. None of them produced any real damage, except those of September, 1590, and December 4, 1689.

THAT International Exhibitions have not quite failed to attract the attention of the world, is proved by the success which is attending the great undertaking at Philadelphia. A pamphlet of sixteen pages "The Forest Products of Michigan at the Centennial Exposition," by Prof. W. J. Beal, of the State Agricultural College, just received, is one of a shoal of similar essays which always emanate from these great shows, and which are often valuable contributions to the knowledge of the natural resources of the countries upon which they treat. Michigan, as is well known, is the head-quarters of the American timber trade; of this fact we are reminded that two-thirds of the best timber known in the New York, Philadelphia, and Boston markets is obtained from Michigan, besides which a good deal comes to Great Britain and Germany. Of North American building woods much in demand in the country may be mentioned pitch-pine, and the timbers of other species of the genus *Pinus*, while among ornamental woods that of *Acer saccharinum*, the sugar or bird's-eye maple, as well as the black walnut, *Juglans nigra*, are extensively used. With the natural characteristic belief in his own country's greatness the author compares unfavourably not only the forests of Great Britain but also those of every other part of the globe, South America included.

MR. G. E. DOBSON, of the Royal Victoria Hospital, Netley, has just issued a very useful monograph of the Asiatic Chiroptera, founded upon a personal examination of almost all the materials available for the study of the Asiatic members of this group both in India and in Europe. To it is added a catalogue of the specimens of bats contained in the collection of the Indian Museum, Calcutta. The confusion hitherto existing in this difficult group of mammals is very great, and Mr. Dobson has done excellent service in putting them to rights. The catalogue is printed in London by order of the Trustees of the Indian Museum.

THE veteran naturalist, Dr. R. Schomburgk, sends us his Report on the Progress and Condition of the Botanic Garden and Government Plantations at Adelaide, South Australia, for the year 1875. The Garden seems to be in a most flourishing condition, the copious and wide-spread rains of the past year having had a most beneficial influence upon it, as upon the country generally. The Zoological branch of the establishment has received many accessions, and a long list is given of plants added during 1875, to those already in cultivation in the Botanic Garden.

THE American naturalists have lately devoted their attention to "Guadeloupe"—not the West Indian Island commonly known by a similar name, but a small island lying off the coast of Lower California, 220 miles south-west of San Diego. Eleven land birds were found by Dr. Palmer upon Guadeloupe Island, and specimens of them were transmitted to the National Museum at Washington. It is a most noteworthy fact that *every one* of these land birds is distinct from those found on the neighbouring

mainland, although each of them has a continental representative more or less nearly related. Variation in Guadeloupe seems to proceed at a rapid pace.

WE have received the Ninth Annual Report of the Peabody Institute of Baltimore, from which we are glad to see that all departments of the Institute have been doing their work satisfactorily during the past year. We notice, from the librarian's report, that of the books taken out of the library a large proportion belonged to the various sciences.

MESSRS. STANLEY of New York and New Britain (U.S.), have devised a metre diagram, intended to supply a want long felt by all who undertake to study or teach the metric system. The diagram contains a full metre, with its various divisions and sub-divisions clearly indicated, and also an English yard with its sub-divisions, so that the two measures can be at once compared. To these are added explanations of the system, a variety of tables, equivalents, rules, &c., the whole forming an excellent apparatus for the effective teaching of this scientific method of measurement.

THE series of the *Bulletins* of the United States National Museum, prepared at the request of the Smithsonian Institution, and published by the authority of the Secretary of the Interior, already embraces some very interesting and important memoirs relating to the collections in the National Gallery. The first of the series, by Prof. Cope, contains generalisations as to the geographical distribution of reptiles. The second *Bulletin*, prepared by Dr. J. H. Kidder, U.S.N., consists of a history of the birds collected by him during the transit of Venus expedition on Kerguelen Island. This, besides describing new species, gives a great deal of information as to the habits of the gulls, petrels, penguins, &c., of that little-known region. The third *Bulletin* completes the notices of the natural history of Kerguelen Island by an article describing the eggs of the birds, together with a list of the plants, rocks, mammals, fishes, molluscs, and other representatives of the peculiar animal life of the South Seas. In the pamphlet is also an enumeration of the specimens collected by Dr. Kershner, of the navy, in New Zealand. The pamphlet concludes with a critical investigation, by Dr. Kidder and Dr. Coues, of *Chionis minor*, the lesser sheath-bill.

THE third edition of Prof. Snow's catalogue of the birds of Kansas has lately been published by the Kansas Academy of Science, and contains some important additions to the previous list. The present enumeration amounts to 294 species, making an addition of twenty-three species and one variety since the publication of the second edition in October, 1872. The number of species mentioned as breeding in the State is 136.

PROF. MARSH continues to find objects of interest in the immense collection of fossil vertebrates gathered by himself and his assistants in the West during the past ten years. We have already referred to his discovery of a new form of pterodactyl, characterised by the entire absence of teeth, and their probable replacement by a horny sheath like that of the bill of modern birds. He now announces two additional fossil birds possessing teeth implanted in sockets. One is a new species of the first division, *Hesperornis*, and the other forms the type of a new genus, *Lestornis* (*L. crassipes*), the remains of which indicated a large swimming bird, fully six feet in length from the bill to the end of the toes.

THE Catholic Universities seem to have been a failure in France. According to an official account published by Government, about a hundred pupils have been registered in law. The number of medical students is limited to a few dozen in medicine, and there are only eight in science. However, the Catholics are collecting funds with unabated spirit, and 3,000,000 francs are said to be in hand for opening a Law Academy at Marseilles.

FROM the Report of the Auckland Institute (New Zealand) for 1875-76, we are glad to see that that society will soon have a new Museum building of its own. The Report contains a list of important papers which have been read at the Institute during the session. From New Zealand also comes the Report of the Auckland Acclimatisation Society, which, amid many discouragements, is doing good work by the introduction of salmon, trout, and various birds into the country.

THE Report of the Rugby School Natural History Society is the largest yet issued, and contains several papers highly creditable to the young members, and showing that their writers are in a fair way of training themselves to be good observers. Among other papers worthy of mention, are the following:— "On the Symmetry of Flowers and Inflorescence," by V. H. Velej; "On Drops," "On Sound," and "On Impressions," by H. F. Newall; "On the Effects produced by Shadows under Water," by H. N. Hutchinson. Appended are various sectional reports and ten plates illustrating the papers, eight of which are drawn by members of the Society. Altogether the Society is to be congratulated on the Report.

A LIST of papers read before the Priestley Club, Leeds, during its first session, October to June, 1875-76, has been published. Thirty-six papers have been read, all of them on subjects of great scientific importance.

MR. G. H. KINAHAN has published in a separate form his paper on "The Lagoons on the South-east Coast of Ireland," read before the Institution of Civil Engineers.

THE *Proceedings* of the Liverpool Naturalists' Field Club, for 1875-6, shows that that Society continues to do good and steady work. There is an interesting address by the President, the Rev. H. H. Higgins, on "The Names of Plants."

PART 4 of Vol. I. of the *Transactions* of the Watford Natural History Society contains a lecture, by Prof. Morris, on "The Physical Structure of the London Basin considered in its relation to the Geology of the neighbourhood of Watford;" a paper by Mr. R. A. Pryor on "The Supposed Chalybeate Spring at Watford, and on the Medicinal Waters in Herts," besides the rainfall in 1875, and miscellaneous notes and observations.

IN reference to Mr. C. G. O'Brien's letter (vol. xiv. p. 123), on the beautiful spring-trap arrangement of the stamens of Kalmia, a correspondent writes that the point has already been noted by Dr. Robert Brown, in his "Manual of Botany," p. 440.

THE following varieties have been added to the tanks of the Royal Westminster Aquarium during the past week:—Toper, or White Hound (*Galeus canis*), Sting Ray (*Trygon pastinaca*), Red Mullet (*Mullus surmulletus*), Boar-fish (*Capros aper*), Comber, or Smooth Serranus (*Serranus cabrilla*), Pope, or Ruff (*Acerina cernua*), Barbel (*Barbus fluviatilis*), English Carp (*Cyprinus carpio*), presented by Mr. W. R. Killick; Sea Cucumbers (*Holothuria niger*).

THE additions to the Zoological Society's Gardens during the past week include eight Jameson's Gulls (*Larus jamesoni*) from Australia, presented by Mr. A. H. Jamrach; a King Vulture (*Gyparchus papa*) from Tropical America, two South American Little Bitterns (*Butorides cyanurus*) from South America, a Green-billed Toucan (*Ramphastos discolorus*), four Sayaca Tanagers (*Tanagra sayaca*), six Festive Tanagers (*Calliste festiva*), six All-green Tanagers (*Chlorophonia viridis*), two Violet Tanagers (*Euphonia violacea*) from Brazil, a Brown Howler (*Mycetes fuscus*) from Panama, a Madagascar Squirrel (*Sciurus madagascarensis*) from Madagascar, purchased; two Australian Bustards (*Eupodotis australis*) from Australia, deposited; an Eland (*Oreas canna*), nine Amherst's Pheasants (*Thaumalea amherstiæ*), thirteen Gold Pheasants (*Thaumalea picta*), bred in the Gardens.

SCIENTIFIC SERIALS

Mind, July.—This number has very little of interest for the general reader. Helmholtz, on the origin and meaning of geometrical axioms, maintains that geometrical axioms, in the form in which it may be maintained that they are not derived from experience, represent no relations of real things, that they have real import only when certain principles of mechanics are conjoined with them, and that then they are amenable to experience, and may be matters of inference.—Prof. Flint makes a clever fight for the non-derivative origin of moral ideas. He is very hard on the associationist philosophers. The laws of association, he says, will not explain how virtue, if at first loved merely as a means to happiness, comes subsequently to be loved for its own sake, apart from happiness. He denies that transformations of this kind are ever performed, and tries to show that in the case of avarice, the typical instance of the associationists, there is no such thing as the love of money for its own sake.—Mr. Pollock attempts to show, in reply to Mr. Sidgwick, that the doctrine of evolution is not quite without ethical value. He doubts whether the problem of the ultimate sanction of ethics in individual thought can strictly be deemed even rational. This is rather sad from our moral philosophers; with theology it has always been rational and simple enough.—Under the title, "The Original Intention of Collective and Abstract Terms," Max Müller endeavours to make out that Mill in his definitions of mind and of matter lost himself among words, and only jumped out of the frying-pan into the fire.—Mr. Shadworth H. Hodgson concludes his papers on philosophy and science. He opposes to pure ontological speculations the psychological impossibility of ever transcending the duality of subject and object. He retains for philosophy, however, a region avowedly beyond science, the same supra-sensible that Lewes rejects.—Mr. Lindsay gives an appreciative account of the Philosophy of Hermann Lotze, whom we are called on to admire as taking account of the spiritual no less than of the mechanical side of the universe. The history of philosophy at Dublin is written by Mr. Monck.—Among the Critical Notices is a reply by Prof. Bain to the arguments by which Mr. Alexander tries, in his "Moral Causation," to establish the doctrine of human freedom. Prof. Bain is exactly in his element, and the argument is exquisitely neat.—In each of the three numbers of *Mind* there have been notes on a question between Mr. Lewes and Prof. Bain, as to the warrant for our belief in the uniformity of nature, which show how difficult it is for philosophers to make themselves understood by one another.

Poggendorff's Annalen der Physik und Chemie, No 4, 1876.—In this number we find the second part of M. Winkelmann's memoir on heat conduction in gases; treating chiefly the subject of the relation of heat-conduction to temperature. The experiments were made with three apparatuses of different dimensions, consisting essentially of a spherical glass vessel with the bulb of a thermometer at the centre. The vessel could be filled with the gas to be examined; it was then placed in melting ice, boiling water, &c., and the time of cooling was observed. The theories of Clausius and Maxwell differ in the law they assign for variation of heat-conduction with the temperature. According to Clausius, the conduction increases proportionally to the square-root of the absolute temperature; according to Maxwell, proportionally to the temperature itself. The experiments of M. Winkelmann so far favour Maxwell's view of the law (though he does not regard them as confirming Maxwell's theory, in which the hypothesis of a repulsive force between the molecules acting proportionally to the fifth power of the distance, does not agree with experience, Thomson and Joule having shown that attractive, and not repulsive forces, act between the molecules). If the heat-conduction of air or hydrogen at 0° be made equal to 1, then at 100° it is equal to 1·364. The co-efficient for carbonic acid is considerably greater; the conduction at 100° (that at 0° being = 1) is 1·593; but it is less than the theoretical value (1·691), the variation of the specific heat of this gas with temperature being taken into account. M. Winkelmann further points out that the temperature co-efficient of friction of gases does not agree with that of the heat conduction.—In a contribution to the theory of the galvanometer, by M. Weber, will be found some useful directions in construction. Among other things he shows that galvanometers with "current-curve" of the form of two parallel lines connected by semicircles will, with only about a tenth expenditure of wire, show one-third greater sensibility than corresponding galvanometers with circular current curve.—M. Neesen offers an explanation of elastic reaction based on views furnished by the mechanical theory of heat as to the constitution of bodies.—M. Holtz describes a good apparatus for rendering visible the duration of the retarded discharge through rotation of the place of passage of the spark. It is only for sparks of long duration, and is meant in some sort as supplementary to the Wheatstone mirror arrangement as improved by Feddersen. The objections to which that apparatus is open, that it involves a weakening of the already weak light of the short discharges for which it is used, and that the extent of air to be broken through by the discharge is not invariable, here fall away.—In a new form of tuning-fork described by Dr. Konig the arms are penetrated by canals, which are connected below, and mercury is pressed up in them to any required height, from a neighbouring reservoir of the liquid; thus the tone is varied. The arms are excited by electrical means, as mere drawing of the bow would give sounds of too short duration.—Among other apparatus described are models of inclined planes, and an arrangement for illustrating the laws of parallelogram of forces.—M. Klein, from the Mineralogical Museum at Kiel, makes some contributions to a knowledge of gypsum.

Memoria della Società degli Spettroscopisti Italiani, January, 1876.—Statistics of solar eruptions in 1871, by Prof. Tacchini. It appears from these statistics that the number of eruptions on the western limb was double that on the eastern, the numbers being 66 and 31 respectively, observed on 122 days. The number on the southern hemisphere was one-third less than that on the northern, and the zone on which the most eruptions occurred is between 70° and 80° N.P.D., one only was seen north of 30° N.P.D.—Notes on spectroscopic observations in 1875, by Prof. Bredichin.—Researches on electro-static induction, by G. Pisati. —Researches on magnetism, by G. Pisati and S. Secchiloni.

February.—Daily notes of spots and faculæ near the limb of the sun, observed spectroscopically and directly, commencing February, 1874, by Prof. Tacchini. The reversal of the lines b, b^1, b^2, b^3, 1474, 4923, and 5017 appears frequent. The same observer gives the positions on the limb of the sun at which magnesium was seen from March to June, 1874.

March.—On the direction in space of the tail of Coggia's comet, by Prof. G. Lorenzoni. Tables accompany the paper, showing co-ordinates for the period from May 18 to July 14, 1874.—Prof. Schiaparelli gives a table of dates for 1876 and 1877, on which falling stars should be looked for. Table of solar spots observed in February and March last at Palermo. Statistics of solar eruptions observed in 1874. It appears that the number of eruptions on the western limb were three times that on the eastern, the number on the north being about one-fourth greater than those on the south.

April.—On the influence of eosin on the photographic action of the solar spectrum upon the bromide and bromo-iodide of silver, by Capt. Waterhouse. The watery solution of eosin gives by absorption two bands at about E and F, the alcoholic solution gives the bands rather nearer the red end of the spectrum. The action of this substance when added to the bromised collodion, or when a watery solution is poured over the sensitive plate, is to give greater sensibility to the plate for the green rays than to the blue, indigo, or violet, the maximum action being below E, extending to about half way to D. Ordinary wet collodion plates prepared with bromo-iodised collodion containing eosin prolongs the spectrum nearly to D.—Solar eruptions observed in 1872 by Tacchini, and spectroscopic observation on the sun in April, 1876.—The transparency of the air, by Prof. Ricco.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, April 1.—A paper lately appeared in this periodical, by Director Mohn, on the cause of the deeper barometrical depressions in winter than in summer, giving the author's reasons for having changed his opinion on the subject since the publication of his "Grundzügen der Meteorologie." In the present number we have a letter from Dr. Gustav Hellmann, upholding Herr Mohn's first explanation. Having shown how difference of barometric pressure depends upon difference of temperature and differences in the heights of the differing columns of air, and upon differences in humidity, and how these give rise to ascending currents, he states that the up-draught must be stronger in winter than in summer, because (1) the differences of temperature between two places are greater in winter than in summer, or the isotherms are nearer together; (2) decrease of temperature with height is half as great in winter as in summer; (3) the air is more saturated with moisture in winter. He lays stress upon

the fact that the barometer can only fall beyond the level due to the above-named differences when more air is carried away in the upper regions than comes in below. In this case the gradient is steeper at great altitudes than on the earth's surface, depending upon the strength of the up-draught, which is strongest in winter.—In the Kleinere Mittheilungen there is an article by Dr. Hann, on the cyclone of October 15, 1874, in Bengal, and one by Baron v. Friesenhof, on barometric maxima and minima in 1873 and 1874.

Nachrichten von der Königl. Gesellschaft der Wissenschaften, Göttingen, Nos. 22, 23, 24, 1875.—In these numbers will be found an account of some comparative experiments by M. Marmé, on the poisonous action of arsenious acid and of arsenic acid. Doses of the two acids containing equal amounts of arsenic (or with a little more in the arsenic acid dose), and diluted with water, were given to animals as similar as possible in age, weight, &c., being introduced directly into the circulation, or into the stomach, or the connective tissue. The symptoms are detailed. Without exception, the doses of arsenious acid proved more rapidly fatal than those of arsenic acid. The acid salts behaved similarly to the free acids. The fact is against Munck and Leyden's view, that arsenious acid in the blood is oxidised to arsenic acid, and that only as such it dissolves the blood-corpuscles, and causes fattening of various tissues and organs. The authors think it probable that when arsenic acid is introduced into the blood it is reduced to arsenious acid, and therefore its action appears more slowly. They further describe some experiments on the use of toxical substances to counteract arsenic acids.—M. Wohler describes the properties of a fluorine mineral from Greenland, named "Pachnolith."—The remaining papers are mostly on chemical subjects, the principal one being by M. Hubner, on two nitro-salicylic acids and their employment in determining the nature of the hydrogen atoms in benzol.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, June 21.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—Mr. Hector Maclean and Mr. Samuel Trickett were elected Fellows, and Dr. L. Rütimeyer, of Basle, a Foreign Correspondent of the Society.—The following communications were read:—1. On the Ice-fjords of North Greenland and on the formation of fjords, lakes, and cirques in Norway and Greenland, by M. A. Helland. Communicated by Prof. A. C. Ramsay, F.R.S. The author described in great detail his observations on the glacial phenomena of Greenland, and applied their results to the consideration of the traces of glacial action exhibited in Norway. His view of the course of events in Norway is as follows:—Before the Glacial epoch thousands of streams commenced the work of erosion and produced valleys. During the Glacial epoch these valleys were enlarged and lake-basins were hollowed out. The descending glaciers ground out fjords to their full length when the Glacial epoch was at its highest, but as it declined the glaciers ground out the inner part to a still greater depth, producing the present characters of the marine fjords, and giving rise to lake-hollows in other places. That the glaciers once extended beyond the fjords is shown by moraine-matter being dredged up. Some of the sea-banks and islands off Christiania-fjord are old moraines; and if Norway should be raised 400 metres, these banks would show as moraines and plains before the lake-basins of the fjords. 2. On the drift of Brazil, by Mr. C. Lloyd Morgan. The author described the position and mode of occurrence of large boulders of gneiss and granite in the red drift of Brazil and on the slopes of hills even at considerable elevations, and stated that, like Prof. Agassiz, he could not see how these could have been transported to their present positions except by the agency of ice. He is inclined to believe that the drift, if of glacial origin, was not formed by glaciers taking their rise in any of the peaks indicated by him, but by an almost universal South-American ice-sheet.—3. Recent glacial and aqueous action in Canada and the drift-uplands of the Province of Ontario, by the Rev. Wm. Bleasdell. Communicated by the President. The author described the glacial action which takes place every winter in Canada, especially on the River St. Lawrence and its large lakes.—4. The glacial climate and the Polar ice-cap, by Joseph John Murphy. The author agrees with Mr. Croll in thinking that a Glacial epoch must be one of maximum eccentricity of the earth's orbit, and that the northern and southern hemispheres during such an epoch must be glaciated alternately but he maintains in opposition to that writer that the glaciated hemisphere must have its *summer* in aphelion. He intends this paper to be a reply to Mr. Croll's objections to this theory as put forth in his work on "Climate and Time."—5. On the discovery of plants in the Lower Old Red Sandstone of the neighbourhood of Callander, by R. L. Jack and R. Etheridge, jun., of the Geological Survey of Scotland. The plant-remains are described as being of a very fragmentary nature. The authors discuss the relationships of these remains with other described Devonian forms, and regard them as most nearly allied to *Psilophyton princeps*, Dawson. They describe the plant with doubt as a species of *Psilophyton*.—6. On an adherent form of *Productus* and a small *Spiriferina* from the Lower Carboniferous Limestone Group of the East of Scotland, by R. Etheridge, jun., F.G.S., of the Geological Survey of Scotland. From the consideration of the characters presented by the more mature valves, the author stated that the nearest affinity of the species of *Productus* appears to be with *P. wrightii*, Dav., but that it shows peculiarities allying it to *P. longispinus*, Sow., *P. scabriculus*, Mart., and *P. undatus*, Defr. He was not prepared to describe it as a distinct species, but suggested for it the name of *Productus complectens*, in allusion to its embracing habit, in case of its proving to be distinct. The *Spiriferina* described by the author was compared by him with *S. cristata*, Schl., var. *octoplicata*, Sow., and with *S. insculpta*, Phill., from both of which it differs in certain characters; but as only one specimen has been met with, he refrained from founding a new species upon it. The specimen is from Fullarton Quarry, near Temple, Edinburghshire.—7. Notice of the occurrence of remains of a British fossil *Zeuglodon* (*Z. wanklyni*, Seeley) in the Barton Clay of the Hampshire coast, by Harry Govier Seeley, F.L.S. In this paper the author described the remains of a species of *Zeuglodon* obtained by the late Dr. A. Wanklyn from the Barton Cliff, consisting of a great part of the skull, about the same size as that of *Zeuglodon brachyspondylus*, Muller. The species, named *Z. wanklyni* in memory of its discoverer, differs from all known species of the genus in the shortness of the interspaces between the teeth.—8. On the remains of *Emys hordwellensis*, from the Lower Hordwell beds in the Hordwell Cliff, contained in the Woodwardian Museum of the University of Cambridge, by Harry Govier Seeley, F.L.S. The remains described by the author consist of some fragments constituting the greater part of the plastron and carapace of a species of *Emys*, for which he proposes for the species the name of *Emys hordwellensis*.—9. On an associated series of cervical and dorsal vertebræ of *Polyptychodon* from the Cambridge Upper Greensand in the Woodwardian Museum of the University of Cambridge, by Harry Govier Seeley, F.L.S. The author described in detail the structure of the atlas and axis and of the five succeeding (cervical) vertebræ; nine dorsal vertebræ were also described.—10 On *Crocodilus icenicus* (Seeley), a second and larger species of crocodile from the Cambridge Upper Greensand contained in the Woodwardian Museum of the University of Cambridge, by Harry Govier Seeley, F.L.S. 11. On *Macrurosaurus semnus* (Seeley), a long-tailed animal with procœlous vertebræ, from the Cambridge Upper Greensand, preserved in the Woodwardian Museum of the University of Cambridge, by Harry Govier Seeley, F.L.S., F.G.S.

(*To be continued.*)

Geologists' Association, July 7.—Mr. William Carruthers, F.R.S., president, in the chair.—Part ii. of the geology of Brighton, by Mr. Howell.—On the British Palæozoic Arcadæ, by J. Logan Lobley, F.G.S.—It was admitted that any classification of the Lamellibranchiate fossils of the Palæozoic rocks must be liable to considerable subsequent modification since the generic position of many species on account of imperfect preservation cannot be given with certainty. American palæontologists had added largely to our knowledge of Palæozoic Arcadæ, and the recent investigations of Mr. Hicks had extended the known stratigraphical range of this family as well as of the class Lamellibranchiata. The author, objected to the retention in Arcadæ of sinupallial genera, and proposed that these should constitute a new group, the *Ledidæ*. After eliminating several of the generic names which had been employed by authors, the genera allowed to stand were separately described, and the species by which they were represented in British Palæozoic rocks enumerated. The stratigraphical distribution of these species was shown by two tables, with which the paper concluded.

Entomological Society, July 5.—Prof. Westwood, president, in the chair.—Mr. Douglas exhibited some rare British

Psyllidæ taken by himself near Lee, Kent, amongst which was *Aphalara renosa*, Först., new to the British fauna, now first identified as living on *Achillea millefolium*.—The President showed some microscopic slides containing specimens of Diptera, &c., prepared with extraordinary care by Mr. Enock. He also brought for exhibition twigs of horse-chestnut from Oxford, that had been attacked by some kind of larva, which had eaten away the inside of portions of the stem, causing the buds to drop off. He was in doubt whether the insect was *Zeuzera Æsculi*, or some other, but he would be glad to know if the destruction to the trees had been noticed elsewhere. He also exhibited two species of Coccus, one of them on Camellia leaves in his green-house which he had previously described in the *Gardener's Chronicle* under the name of *C. Camelliæ*, and which had afterwards been observed by Dr. Verloren in his greenhouse in Holland. The female, which is 1 line in length, discharges a white waxy matter having the appearance of the excrement of a young bird. The other species had been sent to him by the Rev. T. A. Preston, of Marlborough, on a species of Euphorbia obtained from Dr. Hooker, of Kew. The leaves were covered with small scales, to which on close examination he observed two small filaments attached; and these proved to be the caudal extremities of the males. These insects emerge from the pupa backwards, and in consequence they make their appearance with the wings drawn forwards over the head.—Mr. Stevens exhibited varieties of some British Geometræ and what appeared to be a small variety of *Lycæna adonis*, taken near Croydon.—Mr. Baly communicated descriptions of a new genus and of new species of Halticinæ; and Mr. Peter Cameron communicated descriptions of new genera and species of Tenthredinidæ and Siricidæ, chiefly from the East Indies, in the collection of the British Museum.—Part II. of the *Transactions* for 1876 was on the table.

Berlin

German Chemical Society, June 26.—H. Vohl proved that inosite by fermentation yields ordinary, and not para-lactic acid.—W. Moslinger has obtained several octyl-compounds from octylic alcohol (derived from the seed of Heracleum spondylium), viz., octylene, iodide of octyl, octylic and octyl-ethylic ether, octyl-sulphate of barium and mono-octyl phosphine.—H. Brunner and R. Brandenburg have found succinic acid in sour grapes.—E. Klimenko, by treating lactic acid with bromal, has obtained lactid-bromal $C_5H_5Br_3O_3$ identical with the product obtained by acting with bromine on lactic acid.—H. Willgerot has replaced chlorine in dinitro-chlorobenzol by NH_2, by SH and by the residues of aniline and of benzidine.—L. Barth and H. Sennhofer, by treating C_6H_5CN benzonitril with a mixture of oil of vitriol and phosphoric anhydride and afterwards with water, have transformed it into crystals of dibenzamide $(C_7H_5O)_2NH$, the hydrogen of which can be replaced by different metals.—The same chemists have obtained the third isomeric or meta-phenol-sulphurous acid by fusing benzol-disulphurous acid with potash, and interrupting the fusion before both groups SO_3H have been replaced by OK. The result is a potash salt soluble in alcohol—$C_6H_5OK.SO_3K$.—A. Fleischer, in treating diphenyl sulphurea with fuming nitric acid, has obtained tetranitroazoxybenzol—$C_{12}H_6(NO_2)_4N_2O$.—The same chemist described springs containing free sulphuric acid which occur in caverns of the Budos Mountain in Hungary.

July 10.—A. W. Hofmann, president, in the chair.—F. Krafft has transformed iodide of hexyl $C_6H_{13}I$ into perchloro-benzole C_6Cl_6 by treating it with chloride of iodine. The same chemist, conjointly with F. Becker, described the formation of two isomeric dichloro-napthalenes, which, according to these experiments, is always preceded by the formation of an addition product $C_{10}H_6Cl_4$.—V. Merz has transformed a number of aromatic substances into C_6Cl_6 by treatment with ICl_3.—Th. Zoller communicated further researches on the preserving properties of bisulphuret of carbon, and its application for preserving meat, fruit, and vegetables.—E. de Souza described amalgams of the formulæ Na_3Hg, K_2Hg, Au_9Hg, Au_8Hg, $Ag_{13}Hg$, $Ag_{11}Hg$, Ag_4Hg, $Cu_{16}Hg$, $Cu_{14}Hg$, Pb_8Hg.—H. Welde has established the following reaction:—

$$3\left(CS\begin{smallmatrix}OC_2H_5\\SK\end{smallmatrix}\right) + 2CO\begin{smallmatrix}OC_2H_5\\Cl\end{smallmatrix} = 2\left(S\left\langle\begin{matrix}CSOC_2H_5\\CSOC_2H_5\end{matrix}\right.\right) +$$

Xanthogenate of potassium. Chlorocarbonic ether. Disulphodicarbothionate of ethyl.

$$CO\begin{smallmatrix}OC_2H_5\\OK\end{smallmatrix} + 2KCl.$$

ethylcarbonate of potassium.

Disulphodicarbonate of ethyl forms splendid yellow needles.—C. Böttinger has transformed pyroracemic acid $C_3H_4O_3$ into $C_3H_6SO_2$ thiolactic acid. Dissolved in alcohol and treated with zinc pyroracemic acid $CH_3.CO.CO_2H$, yields dimethyl-tartaric acid $\begin{matrix}CH_3—C(OH)—COOH\\ |\\ CH_3—C(OH)—COOH\end{matrix}$ forming well crystallised salts with baryta and potassa.—W. Kelbe has treated chloride of phosphorus with mercury-dinaphthyl, obtaining $C_{10}H_7PCl_2$, which with chlorine yields $C_{10}H_7PCl_4$. The latter with water yields naphthylphosphinic acid $C_{10}H_7PO(OH)_2$.—H. Kohler and A. Michælis have dissolved sulphur in phosphenylic chloride, obtaining phosphenylic sulphochloride $C_6H_5PSCl_2$, an oily liquid yielding diatomic ethers with alcohol and phenol.—C. Liebermann showed specimens of Mr. Rosenstiehl's nitro-alizarine and of cotton dyed with this new colouring-matter; its alumina lake is of a deep orange tint.—A. Oppenheim and H. Precht described the following derivatives of dehydracetic acid: a soluble silver-salt, $C_8H_7AgO_4$, its methylic and ethylic ethers fusing at 90°·8 and 91°·6 respectively; its amide, $C_8H_7O_3NH_2$, fusing at 208°·5; its anilide, $C_8H_7O_3NHC_6H_5$, fusing at 115°; monobromodehydracetic and monochlorodehydracetic acids fusing at 134° and 93° respectively. With PCl_5 dehydracetic acid forms the chloride, $C_8H_6O_3Cl_2$, which, heated with water to 180°, regenerates dehydracetic acid. Hydrogen in statu nascendi does not simply unite, but replaces the oxygen of the acid, forming a compound which will form the subject of further investigations.—The same chemists have found that aceto-acetic ether and aniline form alcohol, acetone and diphenyl-urea—

$$CH_3—CO—CH_2—CO_2C_2H_5 + NH_2C_6H_5 = CO(NHC_6H_5)_2 + C_2H_6O + C_3H_6O.$$

—O. Emmerling and A. Oppenheim subjected the same ether to oxidation with permanganate of potassium, which divides its molecule into oxalic and acetic ethers. The same chemists have prepared aceto-acetate of isobutyl, $CH_3.CO.CH.COOC_4H_9$, boiling at 203°. As this substance by distillation yields dehydracetic acid, while with sodium and chloroform it yields oxyuvitic acid, it is fully proved that neither ethyl nor any other alcoholic radical enters into the formation of these acids, which are equally well produced by all aceto-acetic ethers.—Oxyuvitic acid, $C_6H_2(OH)(CH_3)(CO_2H)_2$, has been submitted by the same chemists to the action of nitric acid, which, when diluted, yields hydro-oxybenzoic acid, $C_7H_8O_3$; when concentrated, and particularly when mixed with sulphuric acid, it yields trinitrocresol, $C_6H(OH)(CH_3)(NO_2)_3$, fusing at 106°. With sulphuretted hydrogen, its alcoholic solution yields dinitro-amido-cresol, $C_6H(OH)(CH_3)(NO_2)_2NH_2$, brilliant dark yellow needles, fusing at 156°. With nitrous acid this substance is transformed into dinitro-diazo-dinitro-amido-cresol—

$$C_6H(OH)(CH_3)(NO)_2 - N = N - NH.C_6H(OH)(CH_3)(NO_2)_2,$$

yellow scales, which at 160° decompose with explosive violence.—H. Wichelhaus has studied the action of naphthylamine on nitro-naphthaline, which may be expressed by the equation—$C_{10}H_7NO_2 + 2C_{10}H_7NH_2 - (C_{10}H_6)_3N_3 + NH_3 + H_2O$. The resulting diamine corresponds to violaniline. The same chemist has tried in vain to repeat the synthesis of indigo published by Emmerling and Engler, 120 experiments in test tubes yielding sublimates consisting of zinc and cadmium only.—W. Hill has prepared methylated allantoin, and transformed methylated uric acid into methylated parabanic acid.—T. Murdoch, by heating alloxantin, has transformed it into hydurylic acid.

Paris

Academy of Sciences, July 10.—Vice-Admiral Paris in the chair.—The following papers were read:—Theorems relating to couples of rectilinear segments having a constant ratio, by M. Chasles.—Philosophy and teaching of mathematics; on the reduction of demonstrations to their most simple and direct form, by M. de Saint-Venant.—On a communication of M. Sacc, entitled "Panification in the United States, and the Properties of Hops as Ferment," by M. Pasteur. He asserts (contrary to M. Sacc), that hop has no influence in raising the dough, and it does not contain a soluble alcoholic ferment. The dough rises because of the development of microscopic organisms; hop may favour or hinder the production of some of these. It gives bread a slight bitterness, which is often liked.—On the carpellary theory according to the Amaryllideæ (fourth part, Narcissus), by

M. Trecul.—Note on the "Study of the Hurricanes of the Southern Hemisphere" of Commandant Bridet (third edition), by M. Faye. The work contains many curious observations on cyclones, but its advocacy of centripetal aspiration is condemned.—New remarks on the question of displacement of spectral lines due to proper motion of the stars, by P. Secchi.—Objections to the last communication of M. Hirn, on the maximum of possible repulsive pressure of the solar rays, by M. Ledieu.—Examination of new methods proposed for finding the position of a ship at sea (continued), by M. Ledieu.—Pliocene man, by M. de Quatrefages. This refers to an Italian work on "Pliocene Man in Tuscany," by M. Capellini.—M. de Lesseps presented a summary report from M. Roudaire on the results of his mission to the isthmus of Gabes and the Tunisian Chotts. These labours have been quite successful, and prove the possibility (M. de Lesseps thinks) of forming an internal lake of 25 to 40 metres in depth, and 400 kilometres in length from east to west, having its entrance at the Gulf of Gabés, and covering a space of about 16,000 square kilometres.—M. Tisserand reported on observations made at Kompira-Yama (near Nagasaki, Japan), during his transit-mission.—M. Favé was elected free member in place of the late M. Seguier.—Experimental researches on magnetic rotatory polarisation (third part). Dispersion of the planes of polarisation of luminous rays of different wave-length, by M. Henri Becquerel. The positive rotations of diamagnetic bodies increase approximately in inverse ratio of the squares of the wave lengths, the negative rotations of magnetic bodies in inverse ratio of the fourth power of the wave-lengths.—On cellulosic fermentation of cane-sugar, by M. Durin. Cane-sugar is decomposed into equivalent weights of cellulose and coulose, under the influence of a special ferment, which is of diastosic nature.—On the aërial Phylloxera, by M. Boiteau.—On the development of elliptic functions and their powers, by M. André.—Experiments of measurement of velocity (of water in canals) made at Roorke, in British India, by Mr. Allan Cunningham, by M. Bazin.—On the difference of potential in the insulated extremities of an open induction bobbin after rupture of the inducing current, by M. Mouton. He seeks to measure the successive values of these differences of tension, and establish some laws of their variations.—On the reactions of chlorine under the influence of porous carbon, by M. Melsens. A reclamation of priority.—On a new butylic glycol (continued), by M. Milan-Nevalo.—Explanation of the impressionability of the black faces of a radiometer by means of the theory of emission, by M. Biot; note by M. de Fonvielle.—On the crystallisation of sugar, by M. Flourens.—Anatomical characters of the blood in the anæmic (continued), by M. Hayem.—Influence of fatigue on the variations of the electric state of muscles during artificial tetanus, by MM. Morat and Toussaint.—On a remarkable case of reduction of nitric acid and oxidation of acetic acid, with production of alcohol, under the influence of certain microzymes, by M. Bechamp.—Influence of physico-chemical forces on the phenomena of fermentation, by Dr. Bastian.—On a new meteorite that fell on March 25, 1865, at Wisconsin, and whose character is identical with that of the meteorite of Meno, by Mr. Smith.—History of natural wells, by M. Meunier.—Mineralogical notices, by M. Pisani.

July 17.—Vice-Admiral Paris in the chair.—The following papers were read:—On the fermentation of fruits, and on the diffusion of germs of alcoholic yeast, by M. Pasteur.—On M. Durin's note concerning cellulosic fermentation of cane-sugar, by M. Pasteur.—On the alteration of urine, *apropos* of a note by Dr. Bastian, by M. Pasteur. The facts do not prove spontaneous generation, but only that certain germs resist a temperature of 100° in neutral or slightly alkaline media, their envelopes, doubtless, not being penetrated in this case by the water.—On the intercellular generation of alcoholic ferment, by M. Frémy. Fruits placed in an atmosphere of CO_2 or H undergo alcoholic fermentation, and an organic ferment is generated which may cause fermentation of sugar.—Fourth note on electric transmissions through the ground, by M. du Moncel. He compares the currents got from couples made with silex of Heronville and electrodes of zinc, platina, &c., with those of a Daniell.—Examination of new methods for finding the position of a ship at sea (continued), by M. Ledieu.—On the measurement of the electric resistance of liquids by means of the capillary electrometer, by M. Lippmann. One special advantage of this method is that the sensibility does not diminish even when the resistance increases indefinitely. The method is independent of polarisation of electrodes.—On a rock of vegetable origin, by MM. Bureau and Poisson. This was found by M. J. Vêla on the bottom of a grotto in the Island of Réunion; it seemed entirely made up of spores or grains of pollen, probably spores of Polypodeæ.—On the transformation of saccharose into reducing sugar, in the operations of refining, by M. Girard.—Detection and determination of fuchsine and arsenic in wines artificially coloured with fuchsine, by M. Husson.—On a new compensator pendulum, by Mr. Smith. He utilises the dilatability of vulcanite.—On three sand boxes on the savane of Fort-de-France, Martinique, by M. Berenger-Feraud.—On the parthenogenesis of Phylloxera compared with that of other pucerons, by M. Balbiani.—Results obtained at Cognac with sulphocarbonates of sodium and of barium applied to phylloxerised vines, by M. Mouillefert.—Results obtained in using iron pyrites against oïdium, by M. François.—Discovery and observation of Planet 164 at Paris observatory, by MM. Henry.—Observations of the same planet at Marseilles, by M. Stephan.—On the circumstances of production of two varieties of sulphur, prismatic and octahedric, by M. Gernez.—Critical researches on certain methods employed for determination of the densities of vapour, and consequences that are drawn from them; by MM. Troost and Hautefeuille.—Action of hydracids on selenious acid, by M. Ditte.—Observations on iodine as reagent for starch, by M. Puchot. Its sensibility is at fault in presence of certain azotised organic matter, such as albumen.—On rhodine, a new reaction of aniline, by M. Jacquemin.—Study of the action of water on glycols, by M. Milan-Nevalo.—On the existence, in Spain, of a bed of nickel ores similar to those of New Caledonia, by M. Meissonnier. This is in Malaga. The first works of exploration recently commenced, have furnished several hundreds of tons.—Anatomical characters of blood in the anæmic; third note by M. Hayem. The weakening of colour and the failure of agreement between this colouring power and the number of coloured elements are the two essential characters of anæmia.—On some phenomena produced by faradisation of the grey matter of the brain, by M. Bochefontaine. If it be admitted that there are motor centres of the limbs in the grey substance, yet the same stimulation (which causes limb-motion) puts in action the muscles of organic life and the glands. But the facts do not prove the cortical substance excitable by faradic currents; the stimulation probably affects the subjacent white matter.—Cutaneous respiration of frogs with regard to the influence of light, by M. Tubini. Frogs deprived of their lungs excrete CO_2 in darkness and in light, in quantities having the proportion 100:134.—On disease of the ox through the inermous tænia of man, by MM. Masse and Pourquier. The rabbit, dog, and sheep are not a favourable soil for development of this tænia, but the ox is.—On vesical microzymes as cause of the ammoniacal fermentation of urine, by M. Bechamp.—On meteoric iron, by M. Yung.—On a vertical column seen above the sun, by M. Penou.—On traces of the presence of man in grottoes in various parts of Provence, by M. Jaubert.

CONTENTS

THURSDAY, AUGUST 3, 1876

OUR OYSTER FISHERIES

THE Select Committee appointed by Parliament "to inquire what are the reasons for the present scarcity of oysters," have issued a short but very sensible Report on the Oyster Fisheries, containing a recognition of the fact that the supply of oysters has for some years steadily decreased, and laying down recommendations for the future regulation of natural *scalps*. The Committee have not given much weight to the "theory of heat and tranquillity," which some naturalists consider essential to the fertile *spatting* of the oyster, but have come to the conclusion that the principal cause of the diminution of our once plentiful supply of oysters is to be found in the continual over-dredging for them in open waters, without allowing any sufficient "close time." In France, as the Committee have found by making careful inquiry, the regulations which hedge round the close season are stringently observed, and in consequence of that exercise of vigilance, the supply of oysters has increased; the Committee therefore recommend that a "general close time" (? for *open waters*) should be established, and that it should extend from May 1 to September 1. This is just the old popular close time, as it used to be considered that oysters were only good for food in the months which had the letter *r* in their spelling—the months from September to April inclusive.

With regard to this regulation of a "general close time," the Committee offer the suggestion, that it ought in some degree to be *permissive*, as there are portions of the sea, especially the estuary of the Thames, where it is doubtful whether any close season for dredging would be required; therefore, power ought to be given to the Board of Trade, after inquiry, to shorten, vary, or determine this close season in any particular case. It is also a recommendation by the Committee that the Board of Trade should have authority in certain districts to prevent dredging for a given time. As regards the deep-sea oyster fisheries, the Committee do not propose any alteration of the present close time, which extends from June 15 to the end of August. The infliction of penalties for buying or selling oysters for consumption during the close season is recommended. The proposed regulations, it is thought, should be enforced under the superintendence of inspectors aided by the services of the Coastguard. The Committee approve the practice of giving grants of foreshore and of sea-bottom to private individuals and companies for the purpose of breeding and feeding oysters.

These recommendations of the Select Committee will, in all probability, be introduced to the House of Commons next session in the shape of a "bill," which will probably in due time become law. The oyster is certainly one of our marine products which we can protect by means of a close time, seeing that the bivalve is a fixture and remains during its lifetime in one place, unless violently removed. There is one point in the economy of oyster life which has not yet been so thoroughly investigated as it ought to be, namely, the age when an oyster becomes reproductive. The period at which the oyster breeds might, we think, be set down with more certainty than it is at present. Some persons say it breeds in its third year; others, that it is not gifted with the power of reproduction till it is at least four years of age. It is a recommendation of the Committee that "no oyster should be sold from the deep-sea fisheries under $2\frac{1}{2}$ or three inches in diameter;" such oysters, in our opinion, would not, on attaining that size, have reached the reproductive age; and it is a fact, we believe, that enormous numbers of the edible bivalve reach the market before they have had an opportunity of reproducing their kind, which is, of course, one cause of the present scarcity. It is laid down as a rule by those practically engaged in the cultivation of oysters, that oysters transplanted for fattening purposes do not breed, or, to put the case in other words, do not get an opportunity of doing so. It is perfectly obvious that, if a large per-centage of our oyster supply is sold before it has been given an opportunity of *spatting*, that that of itself, must tend to abridge the supplies.

At one time the French oyster growers were in danger of exterminating the oyster. From their eagerness to make money they rushed to the market with the produce of their artificial *parcs* before they had been afforded an opportunity of breeding! The natural *scalps* which produce most of the oysters laid on private fattening beds, never cease in their season to reproduce, but the *spat* which they exude does not always fall on proper bottom. Without a good holding on place, a "coign of vantage," the infant oyster is of no account. It may get buried in a muddy bottom, or it may be landed high and dry by the waves of the sea on a place where it will assuredly die, or it may fall on good rocky or stone-covered ground, in which case only it will thrive. "Heat and tranquillity" are not at all necessary, in our opinion, to ensure a good fall of oyster *spat*, because the oyster obeying the laws of nature *spats* at its own season, and there are hundreds of oyster *scalps* yet to be discovered, which owe their formation and subsequent growth to the wafting, by the wind, of a "spot" of *spat* to some particular place, where the infantile bivalves find a holding-on place; a holding on place is all that is necessary for the healthy growth of the oyster. This "theory" was promulgated in the *Times* newspaper some years ago, and we are not aware of anything having occurred since to prove it erroneous.

What is really wanted for the protection of the oyster is the assurance that these animals will not be sold before they have a chance of reproducing their kind. Since the introduction of the railway system, the demand for oysters in distant places has become so great, and the price has risen so high, that oyster culturists are tempted to send immature animals to market, and it is this fact, more than any failure of *spat*, that is leading to the scarcity. There are not, in consequence of the unceasing demand, and consequent high price, so many full-grown oysters left to *spat* as there ought to be, hence the scarcity. Any act of parliament that decrees two oysters to grow where only one grew before, will be greedily welcomed both by oyster culturists and by the public, and we hope that the issue of the present Report will lead to some effective measures being taken for the preservation of the delicious creature ere it be too late.

SMITH ON FERNS

Historia Filicum; an Exposition of the Nature, Number, and Organography of Ferns. By Jno. Smith, A.L.S., Ex-Curator of the Royal Botanic Garden, Kew. With Thirty Lithographic Plates by Fitch. 8vo, 429 pp. (London: Macmillan and Co.)

THE main and most valuable part of this work is a full account of Mr. Smith's scheme of fern-classification, with a complete catalogue of all the known species, arranged according to his views and diagnostic characters of all groups of a higher grade. The author is the patriarch of living fern writers, having worked at ferns with unwearied perseverance and enthusiasm for now upwards of fifty years. In 1823, when he first took charge of the living collection at Kew, it contained only forty species. Sir Wm. Hooker also, as is well known, made ferns his favourite department of botany for the last twenty-five years of his life. In 1846 the living collection had increased to 400, and in 1857 to 600 species. In 1864, when in consequence of failing eyesight Mr. Smith was compelled to resign his appointment, he estimated the number of ferns in cultivation in the country at upwards of 1,000. The whole number of species now known in the world, taking a broad view of what constitutes a species, is not far short of 3,000, and during the last year, certainly not less than fifty new ones have been added to the list.

The great peculiarity in Mr. Smith's plan of fern-classification is that at the outset he divides ferns into two groups, which he calls Desmobrya and Eremobrya, an account of which will be found at p. 65. The difference between them depends mainly upon whether the stipes are continuous with the caudex, or jointed at the base, so that they become detached when the frond withers, like the leaf of one of our deciduous trees. The Eremobrya, which are comparatively few in number, are such ferns as *Polypodium vulgare*, and *Davallia canariensis*, in which the fronds are produced singly from the sides of a creeping rhizome, and are jointed at the base. The Desmobrya, which are perhaps three quarters of the family, and have unjointed stems, may have either the fronds produced in a crown from the summit of an erect caudex, as in the tree-ferns and *Nephrodium Filix-mas*, or produced alternately in a single series from a creeping rhizome, as in *Pteris aquilina* and *Nephrodium Thelypteris*. These last, which are comparatively few in number, are like the Eremobrya in habit, but want the joint.

The old Swartzian and Willdenerian genera, founded upon the shape and position of the sori, and the absence or presence and position of the indusium, fall many of them partly into one of these groups, partly into the other, and this holds good also with ferns in which sori and veining also coincide. So that there are substantially three plans of fern-classification and fern-nomenclature, each of which is represented by a recent work in this country, and their relation to one another is as follows:—All systematists agree in recognising a substantial difference in the shape and structure of the sporangia, the shape and position of the sori, and the absence or presence of an indusium as constituting a genus. In Hooker and Baker's "Synopsis Filicum," now in its second edition, only genera are admitted which rest on these characters, and their number is 76, Polypodium, containing about 400, and Asplenium about 300 species. There is great variation in the arrangement of the vascular bundles in the fronds of ferns. Sometimes they do not join again after once branching. In other cases they join and form meshes of various shapes. A second school, represented in Britain by Moore's "Index Filicum," regard any appreciable difference in veining as constituting a generic character, and this increases the number of genera between two and threefold. The total number of genera admitted by Moore is 178, and of these, twelve go into the Polypodium of Hooker. Mr. Smith's plan carries us a decided step further in the direction of subdivision, and by using the character already explained as a ground of generic separation, raises the number of genera admitted to 220. But in point of fact all the ferns in which the sporange is surrounded by an incomplete vertical ring (Polypodiaceæ), which are three-quarters of the whole order, agree completely in the essential structure of their organs of nutrition and reproduction, so that a large proportion of the genera even of those that admit the fewest number are separated from one another by very unimportant characters, and the great difference that there is in the nomenclature of ferns according to the three different systems does not represent any deep-seated divergence of view, because the systematists of the first school willingly accept the further subdivisions of those that multiply the number of genera, as being the best possible groups that can be devised of subgeneric or sectional value. The book, therefore, is worthy of careful study by everyone who is interested in the subject; it is a complete gathering together in one view of the author's work in the field to which it relates. Remembering how the book has been written, no one can study it without strongly sympathising with the author in the difficulties under which he has rested in thus placing before the world the matured result of his labours, and admiring the energy with which he has achieved so difficult a task in such trying circumstances.

In the way of criticism we have two observations to make: the first, that whoever has undertaken the correcting for the press has done his work the reverse of well. Names of well-known genera, species, authors, and books are frequently misspelt. At p. 65 we have the essential character of Desmobrya made to depend upon venation, and at pp. 98 to 101 we have under both Niphobolus and Colysis all the three genders represented in the adjectival specific names. Secondly Mr. Smith, frequently under a genus, compares the number of species as given in Hooker's "Species Filicum" with that given in Hooker and Baker's "Synopsis Filicum," as if the two numbers represented the same thing. Under Adiantum, for instance, he expressly says that where Sir W. Hooker has made 109 species Mr. Baker has reduced them to sixty-two. He has evidently forgotten that, as was fully explained in the preface to the later work, the plan of the two books is different—that the more condensed "Synopsis" only includes the species known with certainty by the authors; but the "Species," in addition those that have been described by others, but not identified, a large mass of doubtful plants in addition to those that are known fully and clearly, so that the two sets of figures cannot be fairly compared unless this be constantly borne in mind.

J. G. B.

TURNER ON THE PLACENTA

Lectures on the Comparative Anatomy of the Placenta. First Series. By Wm. Turner, M.B. Lond. Pp. 122, Woodcuts, and Three Coloured Plates. (Edinburgh: A. and C. Black, 1876.)

THE anatomy of the Placenta has been studied by the best anatomists from Fabricius and Harvey to Hunter, Von Baer, and Sharpey; but much remained to be done when Prof. Turner took up the investigation; and those who are acquainted with his admirable memoirs, which lie hidden in the Transactions of the Royal Society of Edinburgh, know how much he has done to correct and extend our knowledge. The present volume contains a series of lectures delivered before the Royal College of Surgeons last year, and illustrated by specimens from their magnificent Hunterian museum, as well as from that of the University of Edinburgh. Prof. Turner has also been liberally aided by Dr. Sharpey, Mr. Huxley, and other anatomists with material, so that he is able not only to compare the placenta in man with that in the cat, bitch, cow, sheep, and mare, but also in the hyrax, elephant, seal, giraffe, alpaca, lemur, sloth, grampus, and narwhal. The present volume deals only with the diffuse, cotyledonous, and zonary forms of placenta; a second series of lectures will complete the subject by a similar discussion of the discoid placenta, and we shall then have the most complete monograph on this important structure which has yet appeared.

Prof. Turner begins with a short introductory account of the mucous membrane of the unimpregnated uterus, and especially of its glands, and of the chorion and other fœtal membranes. In describing the amnion, he gives the best account yet published of the curious brown or yellow appendages of this membrane found in various forms and in different species by Bernard, Owen, Rolleston, and others, which are probably identical with the "hippomanes" of veterinary surgeons.

The structure of the diffuse placenta in *Sus*, *Equus*, *Orca*, and other genera is then described. The villi of the chorion do not fit into the orifices of uterine glands, but into inter-glandular crypts, which do not exist in the unimpregnated uterus, and only appear as gestation advances. In Cetacea, as in the pig and mare, the villi do not persist over the whole chorion, but die off from the two poles, having only a certain amount of vascular tissue to represent the mesoblast of the allantois. But in the mare and the grampus there is also a third bare spot which corresponds with the os uteri, and is unrepresented in the pig. In the latter there are numerous bare spots scattered over the chorion, which were described by Von Baer and are now found by the author to correspond to parts of the uterine mucosa without crypts, and sparingly supplied with vessels. Dr. Turner has had the opportunity of dissecting two pregnant Lemurs (*Propithecus diadema* and *Lemur rufipes*), and finds that the form of the placenta in the former species is what M. Alphonse Milne-Edwards described as bell-shaped (*placenta en cloche*), *i.e.* the villi cover the whole chorion except at the os uteri; but in the Red-footed Lemur there are two other bare spaces at the poles of the ovum, so that the placenta *en cloche* is a mere generic, or accidental, variety of the diffuse form. Moreover, the villi came away from the crypts of the uterine mucosa in which they lay, without taking any maternal tissue with them. Thus the placenta of lemurs is neither discoid nor deciduate, and one more link of connection between this group and the true Primates is broken.

In his account of the placenta of the cow, Dr. Turner confirms the description by Von Baer and Weber, of the small pouches scattered over the chorion between the cotyledons, and is disposed to agree with the latter anatomist that they serve as receptacles for the secretion of the uterine glands during pregnancy. Similar "pocket-like" depressions were discovered by the author in the giraffe's placenta which was described by Owen in 1842. In this animal, as in the red deer, the cotyledons are arranged in longitudinal rows, and between them are not only much smaller tufts, but also short club shaped villi, scattered separately or in minute groups over the chorion, which thus approximates to the diffuse form found in the camels and the chevrotains.

In the account of the deciduate placenta, the most important fact established by Prof. Turner is that there are several degrees in the amount of maternal tissue which is detached in parturition. If the ovum is stripped off the pregnant uterus of a cat, it carries with it the whole of the mucosa (decidua serotina) with which the chorion is in contact; but on careful examination of the placenta after its natural detachment at birth, it is found that a considerable amount of the vascular corium has been left behind, and that only the superficial part with the epithelial layer has come away with the chorion. In the bitch, as was pointed out by Prof. Rolleston in 1863, the placenta is still less "deciduate," for there is not enough mucosa detached with the ovum to form a continuous layer on the uterine surface of the placenta. Dr. Turner found that the placenta of a vixen agreed precisely with that of the bitch in this respect; the foldings of the uterine mucosa were so minute as to produce a reticulated structure of the placenta, and a similar arrangement was discovered in a specimen from *Halichoerus gryphus*. A re-examination of the placenta of the hyrax described by Prof. Huxley confirms his account of it, and contradicts the assertion of two French anatomists that it is non-deciduate. The poles of the chorion in the Carnivora are often well-supplied with blood-vessels, though no trace of villi can be found at full term beyond the equatorial region. In the otter and the weasel bare gaps occur in the placental zone, as described by Bischoff in 1865.

The most important points established by Prof. Turner seem to be the following:—

1. That the uterine glands are all compound and tubular, and cannot be divided into two groups, as they were by Sharpey, confirmed by most German anatomists. In this Dr. Turner agrees with Prof. Ercolani, of Bologna.

2. That the uterine glands do not open into the funnel-shaped crypts which receive the fœtal villi, but on the surface between them, and that the crypts are only developed during the progress of gestation. Here also the observations of Ercolani and of Eschricht are supported.

3. That the deciduate character is one of degree. The detached diffuse placenta consists entirely of fœtal structures; in the sheep and cow a large amount of maternal epithelium lining the walls of the uterine crypts comes off

with the ovum, and possibly some of the vascular corium in addition; and even in *Canidæ* and *Pinnipedia* less of the decidua comes away at parturition than in the cat.

4. That the secretion of the uterine glands is absorbed by the intervillous parts of the chorion, and serves as "uterine milk or chyle," the comparison originally made by Harvey.

The important bearing of these researches on the classification of Mammalia is obvious, and they suggest scarcely less important questions as to the nutrition and respiration of the fœtus. P. S.

OUR BOOK SHELF

An Elementary Treatise on Kinematics and Kinetics. By E. T. Gross, M.A., Fellow of Gonville and Caius College, Cambridge, &c. (London: Rivingtons, 1876.)

MR. GROSS says, in his preface to the book before us, that it "is intended to contain as much as is required, under the head of Dynamics, of candidates for honours in the first three days of the mathematical tripos." This object has no doubt determined to a great extent the form which the work has taken, and we see no reason to doubt that it is well suited for the purpose mentioned, and will prove useful to students working for Cambridge examinations. The first five chapters are devoted to the Kinematics of a point, the conception of Velocity being taken up at the outset, along with that of Motion; motion as change of position, and the theorem of the instantaneous centre is only briefly mentioned in a short chapter (the sixth) chiefly devoted to the "Geometry of the Cycloid." The remaining ten chapters of the book are given to Kinetics. The author has taken great pains to put the fundamental conceptions of his subject clearly before his readers, and the parts of his book most valuable to the general student will certainly be those in which he endeavours to crystallise the vague notions too often picked up, at the commencement of a study, as to velocity, force, &c. At the same time we must say that the arrangement of the book is not such as to fit it for general purposes as an elementary text-book on its own subjects. Perhaps this was unavoidable, considering the main object with which it was written, but it is certainly to be regretted. For most purposes it seems better to commence the study of Kinematics by considering motion as change of position only, leaving velocity to be brought in later. This certainly makes it more easy for the student to realise the matter, and obviates such difficulties as occur for instance at pp. 16 and 20, where "change of velocity" means in one place a change of velocity both in direction and in magnitude, and in the other a change in magnitude only. The same treatment also would allow of portions of the Kinematics of rigid bodies being taken up in an elementary manner, while in Mr. Gross's work this part of the subject, the most important one, is practically left untouched. No motion, in fact, is considered, except the motion of a point in a plane. The treatment by the method of instantaneous centres is merely mentioned, although the development of this method certainly furnishes excellent means for the elementary treatment of the more important problems connected with the kinematics of rigid bodies. Similar remarks might be made in reference to the second part of the work, but perhaps it is not fair to criticise from this general point of view a book written chiefly for a special and limited purpose.

Mr. Gross has used geometric illustrations freely and with great advantage throughout his book. We regret that he has adhered throughout to the *parallelogram* of velocities, forces, &c. Surely it is more elegant and in every way better to use three lines than five. Culmann's science can be very little known in this country if we have not yet got even as far as this.

LETTERS TO THE EDITOR

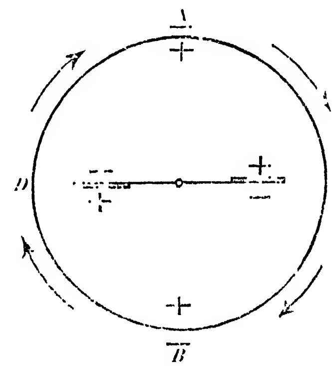
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Direct Motion in the Radiometer an Effect of Electricity

I HASTEN to communicate to NATURE some new facts which are destined, I believe, to throw some light on the theory of the radiometer:—

1. The glass globe becomes negatively electrified upon the whole of its exterior when the instrument is submitted to solar, or even obscure heat radiations of sufficient intensity, and this electricity is more intense upon the hemisphere facing the radiant source than that opposed. It was by means of a proof-plane of large surface and a Bohnenberger's electroscope that I was able to determine the presence of this free electricity. By touching the globe several times in different places with the proof-plane, and then applying it to the electroscope, the effects are very sensible. This electricity cannot be attributed to the friction of the radiometer vanes with the rarefied air of the globe, since the electroscopic indications are not modified when the instrument is inverted, and the vanes thus prevented from moving. Neither, as several experiments show, can it be attributed to feeble evaporation on the exterior. This development of electricity upon the exterior surface of the globe is of course necessarily accompanied by the development of positive electricity upon the inner surface.

2. When exposed to radiation, the black face of the vanes is electrified positively, and the bright face negatively. This I have proved in the following manner:—I took a strip of mica two decimetres long, and having coated one of the sides with lampblack, I suspended it in a Coulomb's Torsion Balance, having previously electrified the metallic disc of the balance-needle with positive electricity. The blackened side faced the disc. I then



allowed the radiations from a gas-flame to fall upon the blackened surface of the mica strip. Notwithstanding the light was at some distance, and had to penetrate the thick glass shade inclosing the balance, the needle was rapidly repelled several degrees, showing that the blackened face was positively electrified under the influence of radiation. I then turned the strip of mica so that the bright side faced the disc and allowed the radiation to fall as before upon the blackened surface. The needle indicated an attraction between the disc and the mica, proving that the bright surface was negatively electrified.

3. To anticipate the objection that these electrical manifestations are too feeble to account for the rapid revolution of the vanes, I gently rubbed the globe with a brush composed of glass threads; the electricity developed on the globe acting by induction upon the nearest mica disc of the radiometer caused a brisk oscillation. I then measured the intensity of this electricity by means of the proof-plane and electroscope, and there were no indications of greater intensity then when the globe was electrified by radiation.

4. From the above facts the following theory, if I mistake not, necessarily flows. The radiometer is electrified as represented in the figure. At C the black face of the vane is turned towards the radiant source, and in this position the vane will be forced to move in the direction A C B; when it arrives at D, the direction of the rotation which the attractive and repulsive forces

necessarily produce will not change. It will be that indicated by the arrows, namely, B D A. The direct and ordinary movement in the radiometer is thus explained in the simplest manner.

JOSEPH DELSAULX, S. J.

11, rue des Récollets, Louvain, Belgium, July 22

A Brilliant Meteor

LAST Tuesday evening, July 25, at three minutes past 10 P.M., a magnificent meteor was observed here. Its first appearance was hidden from me by a tree, but the rest of its long course was open to view. It travelled straight from S. to N. between the directions S.S.W. and W. Its apparent size was that of Jupiter. When first seen it was of a brilliant violet colour. This changed to bright green and red, and towards the end it was, I think, green in front, red behind, and where a number of globules which broke off seemed to follow it. The body of the meteor was pear-shaped. No luminous train was left after its disappearance. The motion was much slower than that of common aerolites, and probably the phenomenon lasted about two seconds. It would be interesting to know what was seen of it in the West of England and in Ireland.

Pembroke Lodge, Richmond Park, July 28 F. A. R. RUSSELL

ON Tuesday, the 25th, I was seated with my eyes looking westward, when at 10.5 P.M. a most remarkable meteor passed before my vision, which exceeded in brilliancy of colour and in dimensions any phenomenon of the kind that I ever witnessed in the whole course of my life.

The main body of the meteor was a vivid emerald green, with a large spherical head tapering away into a tail of fiery red colour, followed up by a luminous track.

Its trajectory was almost horizontal, emanating from the constellation of Aquila, passing through that of Hercules, curving slightly downwards, and passing a few degrees beneath Arcturus; a short distance northward of that great star the meteor suddenly collapsed with a bright effulgency, and vanished from sight.

Its velocity appeared as being somewhat slower that what I have observed on similar occasions. It was present to the observer for more than five seconds of time, sufficient time to leave on the mind of the observer a distinct impression of the meteor's various aspects.

Owing to the dry condition of the atmosphere, the apparent proximity of the meteor was very striking; the brilliant flash of colour at first sight produced the effect that a large rocket had been fired off in the vicinity, for it was very similar in colouring and shape to many rockets displayed by pyrotechnists.

Soon after the meteor had disappeared I observed three very faint shooting-stars to fall from a high altitude downwards to the track which the meteor had taken.

I furnish you with these observations, which may interest your readers, especially those who were fortunate enough to observe this splendid phenomenon. ERAS. OMMANNEY

6, Talbot Square, W., July 29

D-line Spectra

LAST March you were good enough to publish in NATURE (vol. xiii., p. 366) a request for some explanation of the extremely different, and indeed opposite, reactions afforded to *boric acid* by the yellow or D-line spectral flame emitted from soda or its salts, and from platinum respectively, when treated with the blowpipe.

No explanation has been vouchsafed; and it may be now added to that fact that, among the millions of substances in nature emitting this D-line producing-flame when heated before a blowpipe, sodium salts are the *only ones* which give the reactions of sodium; all others affording extremely marked reactions of an *exactly opposite* character. W. A. ROSS

July 24

Pyroxidation

WILL any of your chemist contributors be so kind as to afford in your columns an explanation of the following phenomenon?

If we heat before a blowpipe on a piece of aluminium plate (which has a side of four inches perpendicular to the blowpipe flame) a fragment of pure antimony, we have three sublimates deposited on the perpendicular side of the plate in the following order:—

(*a*) Sb_2O_5 (strongly reddening litmus paper) *highest*.
(*b*) Sb_2O_3 (faintly „ „ „ intermediate.
(*c*) A *black* sublimate (?) lowest.

I want to know why a substance similar to another, except that it contains two more atoms of oxygen, and has therefore a higher specific gravity, travels perpendicularly up the plate to a more elevated position? W. A. ROSS

July 24

ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE[1]

V.

Results of Experiments on Resuscitation.

IN my last communication I described a method of practical study by experimentation which was intended to demonstrate the best means of restoring to life those human beings who by accident are thrown on the confines of death. To thoughtful and feeling minds this study is sublimely solemn, but I see that a writer in one of the contemporaries of NATURE has found it possible, in his zeal against experimentation on animals, to make my observations on the subject the matter of a jest at my expense. In order to render his jest applicable, the writer has also perverted my statement so as to make a simple illustration of a discovered fact appear as if it were presented in the light of the fact discovered. It will be remembered by the readers of these articles that after I had described, in my last essay, the observations relating to the effect of galvanism on expiring muscular power, I enforced the lesson by illustrating the difference of effect that might be expected to occur from carrying an exhausted animal to a place of succour and of making it travel to the place. The writer I refer to states this illustration as the fact which I have arrived at by experiment, and thereupon founds his joke, which he borrows from *Gil Blas*. The circumstance of this criticism has an interest for which I am thankful. It has suggested to my mind something which might not have occurred to it, viz., that in my desire to be very brief in these abstract reports I have neglected to introduce a few detailed arguments of first importance, which ought not, perhaps, to have been omitted in any case, but which I am now compelled to supply.

After the discovery of the process known as galvanism, and the researches conducted by Galvani, Volta, and Aldini on the influence of the galvanic current on animal life, the application of the current for the purpose of resuscitating persons who were apparently dead became the common practice of medical men. The extraordinary experiments conducted by Aldini at the College of Surgeons during the day of January 17, 1803, on the body of a malefactor named Forster, made an impression on men of science which was probably without parallel. The malefactor, after being hanged and after being exposed for a whole hour to a temperature two degrees below freezing-point, was carried to a house near to Newgate, and, in pursuance of the sentence, was delivered over to the College of Surgeons. The master of the College, Mr. Keate, here re-delivered the body over to Aldini, who was the nephew and devoted follower of Galvani, and the action of the galvanic current upon the dead man was demonstrated. I need not describe minutely the strange phenomena that were observed during the demonstration. Carpue, the anatomist, took share with his pupil Hutchins in the anatomical part; Cuthbertson, an eminent mathematical instrument-maker, the Browning of that day, directed and arranged the galvanic apparatus, which consisted of three troughs of forty elements each; Mr. Keate took duty in observing, and Aldini directed the operations. Fifteen experiments were carried out, and such were the muscular movements excited in the dead man by the current that the most sanguine expectations

[1] Continued from p 252.

were afterwards expressed as to the power of galvanism to restore suspended life. Aldini, indeed, made a kind of apologetic observation that his "object in applying the treatment to the dead malefactor was not to produce re-animation, but merely to obtain a practical knowledge how far galvanism might be employed as an auxiliary to other means in attempts to revive persons under similar circumstances." The observations of Aldini were as impressive as they were remarkable. They opened a new line of inquiry and of research; but in their very wonder lay a source of many errors, and from these errors sprang a false rule of practice, which was unfortunate in its results for a very long time.

One error consisted in attributing to the action of galvanism something more than its power of calling forth the natural remaining irritability of the muscles of those in whom the signs of life are suspended. It was noticed that the muscles of the malefactor retained their irritability and power of contraction under the galvanic stimulus for seven hours and a half after the execution. The credit of this, which was due entirely, as my experiments have since explained, to the cold to which the dead body was exposed, was given to the galvanism; here was a second error. The greatest error was conveyed in an inference drawn, and I think naturally drawn, by Aldini, at that time, that the "application of galvanism gives new energy" to the muscles, and therefore that galvanism ought to have first place in the practice of resuscitation. "The well-known method," he says, "of injecting atmospheric air (artificial respiration) ought not to be neglected; but here, likewise, in order that the lungs may be prepared for its reception, it would be proper previously to use galvanism, to excite the muscular action, and to assist the whole animal system to resume its vital functions."

It was all but impossible that teaching such as this, backed as it was by experiment so remarkable, should fail to exert an influence on the practice of medicine in the treatment of suspended animation. It did, in fact, exert the most potent influence. It threw artificial respiration, which had been projected by Hooke, from experiment on animals, and which had been strongly urged by Fothergill and John Hunter, into the shade, and it gave to galvanism for nearly half a century the first place as the means, not simply for calling into motion the remaining energy of the dying muscles, but, as Aldini imagined, for "giving new energy" to the muscles. From the date of that theory, the battery, and after it was discovered, the electro-magnetic machine became the instruments of instruments for resuscitation.

Thirty years ago, when I was commencing my medical career, the application of the galvanic battery in cases of sudden death from drowning, from suffocation, and from other similar forms of sudden accident, was still the approved practice. The mode of operation was to place one pole of the battery at the nape of the neck, and the other pole below the diaphragm, and by passing shocks through the inclosed parts, to excite the muscles to contraction, so as to restore the movements of respiration. The effect was for a little time very startling; it seemed as if the natural function were called again into play; but in the end the motion excited became feebler and feebler; at last the stimulus failed, and the patient was declared to be dead. I recall many instances of this kind. I know of one instance of suspended human life from accidental suffocation, in which, when the natural breathing was just becoming restored by artificial inflation of the chest, the arrival of a battery and the application of it to expedite recovery was followed by complete cessation of all motion in response to the stimulus, and by absolute death. I know of another instance in which a needle from one pole of the battery was carried down to the heart, under the hope of exciting motion from the centre of the circulation, but, as it was said, "without avail."

In this position the method of resuscitation by means of galvanism stood until my experiments on animals recently dead from anæsthesia commenced. In experimenting with the galvanic current I was desirous of making it more precise in action, my original idea being that the constant failure of it as a means of recovery was due, not to fault in principle, but to some mistake of detail. With the research in this direction came the observation, altogether unexpected, that galvanism, even when it is made to reproduce the natural movements of respiration with such precision that they tally completely with the natural respiratory acts of the animal as those were counted and measured while the animal was in health, not only fails to restore the natural respiration in the majority of cases, but in the majority of cases destroys the respiratory power altogether. In brief, the experiments showed that the theory of Aldini, that galvanism "gives new energy" to the muscles was wrong, while the fact came out that the effect of the galvanism is only to whip into silence the muscles that are already well nigh dead. This, which was found true in respect to the muscles concerned in respiration, was found to be equally true in respect to the heart.

The correction in matter of principle deduced, the comparison followed between artificial respiration carried out with a perfect instrument and the effect of galvanism, in the same forms and modes of death. Therewith followed the result that in extreme states where recovery is nevertheless all but certain by the process of artificial respiration supplied from the hand of the operator, death is all but certain from the application of the galvanic stimulus. The lesson taught by experiment was thus doubly valuable; it exposed the failure of a deceptive and fatal agency for means of restoration; it prompted the improvement of rational and successful means of restoration.

As the experiment with galvanism on the failing muscles of the lower animal opened my eyes to read the real facts, the reason came vividly enough before me, why in the human subject I had seen, with pain beyond measure of expression, the vigorously stirred muscular mechanisms sink under galvanic stimulation into irrevocable rest. Then I could point out and correct the error. In the absence of the experiment, the correction had been impossible. No man on a mere speculation would have dared to withhold from a dying patient the application of galvanic stimulation, until the danger of the practice was proved by experimental science. Yet how solemn is the issue let one example tell! Before the experiments I have related were performed and the new order of facts were elicited by them, I should—in the case of that child, whose history was told in my last communication, and who recovered by means of artificial respiration when the natural respiration had ceased and all the signs of death were developed—have tried, from the practice I then knew, to excite the respiratory power by galvanism, and should have believed, whatever had been the result, that the practice was, under the circumstances, the best that could have been employed. Now I know that the galvanic current would have killed the child outright, as surely as I know that the artificial respiration raised him back into life.

Aldini reports that after the observations on the malefactor, Forster, were concluded, Mr. Keate, the Master of the College of Surgeons, proposed to make comparative experiments on animals. If this had been done at that time and the relative merits of artificial respiration supplied by the power of the operator, and of artificial respiration excited by galvanism from the muscles of the affected subject had been compared, the original error of Aldini that the galvanic current "gives new energy" would at once have been detected, and it would have been seen that the current does no more than disperse the flickering power which the dying muscles retain. As far as I

can ascertain no such comparison was instituted, and so, for nearly half a century, a practice prevailed which must have been constantly taking away the last chances of human life, while a truly saving practice,—artificial respiration,—remained without an improvement from the time of John Hunter, in last century, to that of Marshall Hall, who, in our own days, gave it new and prominent importance.

A dozen painless and carefully-conducted experiments made on inferior animals which were exposed at any moment to be knocked on the head for food, to be killed or mortally maimed with shot, or to be hunted to death in the field or warren, would have taught, in 1803, that the passage of a galvanic current through the muscles of a body recently dead confers on those muscles no new energy; that the current in its passage only excites temporary contraction; that the force of contraction resident in the muscles themselves is but educed by the excitation, and that to strike the life out of the muscles by the galvanic shock without feeding the force, expended by contraction, from the centre of the body is a fatal principle of practice. The experiments unfortunately were not performed, and the error, therefore, fatal as it was, continued without question, until my own unexpected observations revealed it in the light of an error and made it so self-evident that the illustration through which it may best be explained, admitted of being treated, by one who was wise after the event, as a subject for jest.

"Vidi ego, naufragium qui riserat, aequore mergi."

I will not copy the comment of the poet: far more congenial to me were it to save the endangered life.

It is from experiences such as I have given above, and in many instances, that the necessity for experimentation on the lower animals forces itself on the minds of the members of the medical profession, and especially on the minds of those who are most earnest to remove fatal errors of practice and to devise saving methods. If it were only kept steadily in view that we medical men are always dealing with fatal accidents and fatal diseases; if it were only kept steadily in view that we are always asking ourselves—Is this we are doing for the best? Or, as new light dawns on us: May this we are doing be for the worst rather than for the best, and may the old practices taught to us have rested on a false foundation? If these things were thought of, then our position would be better understood and our actions more correctly appreciated. I believe those who are most severe upon us would be most considerate under this discipline of reason if they would give it trial, and that the very impulses of kindness. I will even say of tenderness, that lead many to oppose experimental inquiry would actually make them experimentalists if they could once realise the highest responsibilities that devolve on the medical scholar. Nay, I am not without hope that my jesting critic himself, if he ever had to stand, as we physicians have to stand, over the body of one of his fellow men, who, in the midst of health had just passed into doubtful death: if this critic, I say, had to stand there wondering what he should do to recal the life, uncertain whether what he was about to do were for the best or the worst; he, I think, would lay aside *Gil Blas*, would be humanely tempted, to risk the sacrifice of the life of a lower for that of the higher animal, and would transfer the rabbit he had provided for his dinner, to the experiment room instead of the kitchen.

BENJAMIN W. RICHARDSON

(*To be continued.*)

OUR ASTRONOMICAL COLUMN

HUTH'S "MOVING STAR" of 1801–2.—At the beginning of the present century, when, although Bode and some few others had been looking forward to such a discovery, astronomers generally were startled by Piazzi's accidental detection of the small planet Ceres, we read of observations of more than one so-called "moving star," which, after progressing slowly for a short interval, finally disappeared. The most singular narrative refers to an object said to have been remarked by Hofrath Huth, at Frankfort-on-the-Oder, on the night from December 2 to 3, 1801, particulars of which were communicated to Bode in several letters during the ensuing five weeks. If the observations are *bonâ fide*, there is yet a mystery attaching to the object to which they relate. Huth was one of the three independent discoverers of the periodical comet now known as Encke's, on October 20, 1805, Pons and Bouvard sharing with him an almost simultaneous discovery, and he did other astronomical work. Writing to Bode on December 5, he says: "In the night from the 2nd to the 3rd of this month, I saw with my 2½-feet Dollond, in a triangle with θ and δ Leonis to the south-west, *a star with faint reddish light, round, and admitting of being magnified.* I could not discern any trace of it with the naked eye; it had three small stars in its neighbourhood." He writes again on the 15th, that unfavourable weather had allowed of his observing the object only on three occasions, which appear to be on the early mornings of the 3rd, 13th and 14th, and he concludes from his observations that it had a slow retrograde motion to the south-west. From the 13th to the 14th, by eye-estimate, it had retrograded 4′ of arc, and from the 3rd to the 13th at most 30′. He forwarded to Bode at this time a diagram of the neighbouring telescopic stars. On December 21 he writes again that he had only succeeded in observing his moving star on one additional night, that of December 19–20, when he found it "near four stars apparently situate to the westward, about half a diameter of the full moon below a smaller one." Its path appeared directed towards i Leonis and towards the ecliptic. He adds: "Of the motion of this planet-like star I can now no longer doubt, since I have observed a difference of $\frac{7}{8}$° nearly, between its positions on the 3rd and 20th." In a fourth letter, dated 1802, January 12, he informs Bode that he had seen the star on two later nights, those of the 1st and 2nd of the same month from 11h. to 14h., with many telescopic stars in its vicinity, of which he enclosed a diagram, by eye-estimate only, with the path of the object.

He mentions that on January 1 the star was even smaller than one of the satellites of Jupiter, and on the following night he had difficulty in perceiving it in close proximity to a star towards which it was moving. On the 5th he could discern only now and then, to the right of the star, on the left of which it was situated on the 1st and 2nd of January, and at a very small distance from it, a glimmer, but the star's former place on the left was vacant. He concludes that the object must have been receding from the earth, and might perhaps have been more distinct and larger before December 3. On the night of January 6 there was no trace of it. He closes this final letter by saying that he would have gladly learned that some other astronomer had observed this star and confirmed its motion, and expressing his regret that Bode had not succeeded in finding it. On the latter point Bode remarks that the weather during December had been but very rarely favourable for observation, and in the few moments that the sky was clear he had occupied himself with his "Seeker" and Dollond, partly in giving attention to the neighbourhood of Huth's star, and partly to the region in which Ceres was expected to be recovered on her second appearance. He also remarks on the imperfect manner in which the star's positions had been communicated to him, but concludes that "without doubt it was a distant comet," and its great distance caused it to appear without nebulosity. He supposes it on December 3 to have been in longitude 156° 20′, with latitude 10° 40′ north, and on January 2 in 154° 20′, with latitude 8° 50′. Huth's rough diagrams are reproduced in the *Berliner Jahrbuch*, 1805,

but they are on a very small scale, and no two persons are likely, perhaps, to agree as to the inferences to be drawn from them. We may remark, however, that the arc of great circle between Bode's extreme positions exceeds the length of the path, as described in Huth's letters. The following places result from an examination of the figures with the particular view to identify several of the telescopic stars entered in the larger diagram :—

1801, Dec. 3.	Longitude ...	157°·0	Latitude	+ 10°·5
,, ,, 14.	,, ..	156·7	,, ...	+ 9·9
1802, Jan. 1.	,, ...	156·2	,, ..	+ 9·1

Calculations founded upon the deductions from Huth's diagram lead to no satisfactory, indeed no probable, results. The ordinary formulæ fail, but the distance of such an object could hardly have been great.

With regard to the *bona fides* of Huth's observations, it is worthy of remark that he wrote several letters to Bode, while according to his own showing, observations would have been very practicable, but for the unusual prevalence of clouded skies; while there is no doubt of the looseness with which he gave its positions.

Next week we shall refer to a similar astronomical puzzle, or myth, as perhaps some readers may be disposed to consider it.

VENUS IN INFERIOR CONJUNCTION.—Mr. J. Birmingham, Millbrook, Tuam, writes:—"In a careful measurement of Venus at the late inferior conjunction, I found proportionally that the full diameter was no more than 200, while a perpendicular from centre of line between cusps to the limb was from 145 to 150."

THE AUGUST METEORS.—The earth arrives at the descending node of the third comet of 1862 in the track of which the August meteors are supposed to circulate, about midnight, on the 9th inst. The comet itself is distant from the earth 27·8 times the distance of the earth from the sun, requiring yet some forty-seven years before the aphelion point will be reached, and it once more begins to approach these parts of the system. Though it will soon attain a distance from the sun equal to the mean distance of Neptune, its heliocentric latitude is so large, there cannot be any near approach to the planet. The ascending node falls not far from midway between the orbits of Saturn and Uranus, while as is well known at the opposite node, its path almost meets the track of the earth, less than two distances of the moon separating them.

THE KEW GARDENS REPORT

DR. HOOKER'S report on the celebrated gardens under his direction contains this year some facts that will be noted as starting-points in the history of scientific progress at Kew. Thus at the outset we are reminded that a sum of money was included by the Government in the estimate of last year for the purpose of erecting a new building for the herbarium in which will be deposited not only the unrivalled collections of dried plants, but also the valuable library, MSS., and collection of drawings of plants. The great importance of a fire-proof building in which to deposit these valuable treasures, cannot be over-estimated. The old house once occupied by the late King of Hanover, in which the herbarium is now and has been contained for nearly a quarter of a century, has become literally crammed; therefore, both on the score of safety and convenience, the new building which has been commenced since Dr. Hooker wrote will be welcomed by botanists of all nationalities.

Another point in the future history of the Gardens is the erection of a laboratory. Dr. Hooker points out that one of the recommendations of the Commission on Scientific Instruction and the Advancement of Science was, "That opportunities for the pursuit of investigation in physiological botany should be afforded at the Royal Gardens at Kew." To carry this out, T. J. Phillips Jodrell, Esq., M.A., generously placed the sum of 1,500*l.* at the disposal of the authorities, out of which the building has been erected, and will be fitted with apparatus for chemical, physiological, and microscopical work. The design for this building, in which we anticipate a great deal of interesting work will be conducted, is exhibited in the Loan Collection at South Kensington. It is pleasing also to note that "the lessons given to the young gardeners in the evening, in chemistry, meteorology, structural and economic botany, and upon which the attendance is voluntary, continue to give satisfactory results." These lessons, with demonstrations from such rich collections as those of Kew, cannot fail to impart a sound knowledge on those subjects immediately connected with botany, and to prepare the *employés* for important posts in India and the Colonies. Many plants of botanical interest, as well as of economic value, have flowered in the Gardens during the past year for the first time in this country, and have been figured for the most part in the *Botanical Magazine*. With regard to the Blue Gum (*Eucalyptus globulus*), about which so much has recently been written, Dr. Hooker points out that the plant having been so largely distributed and planted, will probably prove to be useful in another way—that of a timber tree, in countries not too hot for its growth. "On the Neilgherries, where Australian trees have been largely introduced, one of the most valuable, the *Acacia Melanoxylon*, proves to be all but valueless, owing to the ravages of various Loranthaceous parasites. The *Eucalyptus globulus* is, however, reported by Dr. Bidie to entirely escape their attacks. He attributes this immunity to the 'deciduous bark, the seeds' (of the parasite) 'thereby being dislodged before they can germinate and gain a hold.'" Liberian coffee, which is of a more robust habit, and produces larger seeds than the *Coffea arabica*, has been distributed with uniform success to most of the coffee growing countries, foreign or colonial, foremost among them being Bahamas, Bangalore, Barbadoes, Bermuda, Calcutta, Ceylon, Dominica, Jamaica, Java, Madras, Mauritius, Montserrat, Natal, New Grenada, and Rio de Janeiro.

The introduction into India of the South American rubber-producing plants has occupied, and is still occupying, considerable attention. The successful acclimatisation of the Para rubber-tree (*Hevea brasiliensis*), as well as of the Central American plant (*Castilloa elastica*), is a matter of great importance, affecting as it does our future supplies of this invaluable substance. Of the peculiar and interesting plant, *Pringlea antiscorbutica*, or Kerguelen's Land cabbage, Dr. Hooker announces the receipt of seeds both from the *Challenger* and Transit of Venus expeditions, although, however a number of fine young plants were raised, they have nearly all since perished, a similar fate having befallen those at the Botanic Gardens of Paris, Cape town, and Edinburgh, showing that the plant is very intolerant of warmth.

In the Museums where the collections are constantly increasing, one new feature is specially noticed, that of the separate collection illustrating vegetable teratology and pathology. This collection has rapidly increased since its formation two years since, and will, no doubt, in course of time, prove valuable to students in these interesting branches of botanical science, the more so as no public collection has hitherto existed of this kind, the materials consequently being scattered far and wide.

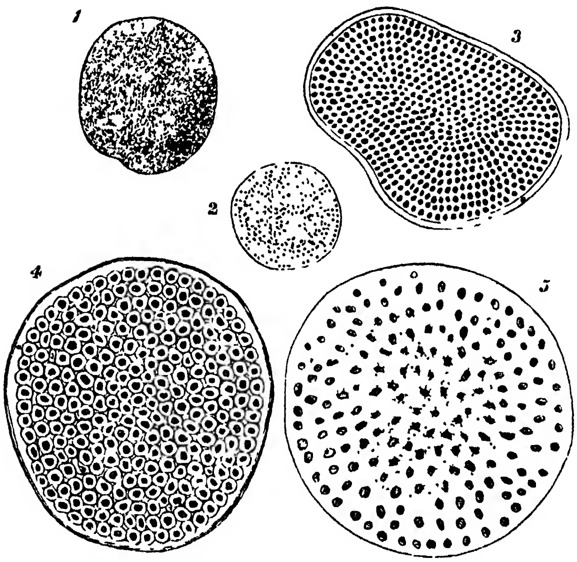
The herbarium has been considerably enriched during the past year, notably by the collections of the late John Stuart Mill, who, besides his other achievements was a diligent collector, and a good botanist; also from other private collections, as well as those of the *Challenger* and Transit of Venus expeditions.

ON THE CLASSIFICATION OF THE VEGETABLE KINGDOM[1]

I.

CLASSIFICATION is a natural propensity of the human mind. If our attention finds itself directed to a large number of objects, about which we desire to inform ourselves, a desire to economise our labour, or even render it possible, at once leads us to endeavour to throw the assemblage into subordinate groups. The result, and indeed end, of this process is to enable us to frame general statements about these groups which cover all the things comprised within them. In the case of a naturalist it is desirable that the groups should be so constituted as to admit of as many general statements as possible being made with regard to them; and in proportion as our classification allows us to do this successfully, we say it is a natural one—one conformable to the order of nature—and such as nature herself would indicate if the task were assigned to her rather than undertaken by us.

The question, however, immediately arises, What is the cause which brings about this possession of common



Figs. 1-5.—Development of colonies of *Bacterium rubescens* after Lankester ("Quart. Journ. Micr. Soc.," 1876, Plate III).

characters by each member of a group of organisms, and renders their natural classification possible? We are now able to answer with a very high degree of probability of the explanation being the true one, "that propinquity of descent—the only known cause of the similarity of organic beings—is the bond, hidden as it is by various degrees of modification, which is partially revealed to us by our classifications."[2]

The earliest attempts at classification seized upon the most striking superficial distinctions. When Solomon "spake of trees from the cedar tree that is in Lebanon, even unto the hyssop that springeth out of the wall," it is quite evident that mere *size* was the point of comparison which aided the process of passing them under review. And till the time of Ray and the beginning of the eighteenth century the classification of plants into trees, shrubs, under-shrubs, and herbs held its ground, though nothing is now better understood than that size, which is a mere matter of habit and mode of growth, is no clue at all to the real affinities of plants. It is easy to see in point of fact when we have once grasped the principle of descent as the cause of resemblances, that those characters which are most valuable for classificatory purposes, are generally those which are least prominent. From age to age organisms may vary in response to the changes of the external conditions to which they are exposed. Nevertheless, underlying the most manifold modifications, some apparently insignificant detail of structure or development will be handed on unchanged, because it has never happened to conflict with the stress of existence, and such a detail will reveal the story of relationship which the comparison of more striking, but really less essential (because *adaptive*) external modifications would perhaps completely obscure.

Thus, comparing the two great departments of activity, into which the life of plants is divisible—nutrition, *i.e.*, all that concerns the growth or multiplication of the *same* individual, and reproduction, *i.e.*, all that concerns the production of a *new* individual, while characters drawn from nutritive structures (such as branching and texture of stems, form of leaves, &c.), have proved of little value, those taken from reproductive structures have proved of the highest importance for purposes of classification. And the reason is that a plant must live before it can reproduce. The stress of competition is harder on the nutritive side of its life than on the reproductive. Habit of growth, which is the expression of the plant's attempt to adapt itself to the conditions of existence prescribed to it, must vary as the conditions vary;

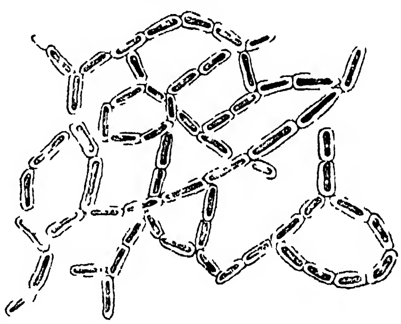


Fig. 6.—*Zoogloea* stage of *Bacterium rubescens* after Lankester ("Quart. Journ. Micr. Soc.," 1873, Plate XXIII).

but the development of ovules and homologous organs comes when the battle of life, so to speak, is won. Their details of structure, and the development of the embryo-plants which proceed from them are, at any rate, in a great measure relieved from the necessity of undergoing adaptive changes. They undergo, no doubt, progressive modifications, but these are comparatively slow and are perhaps brought about in part by the correlation of growth, which causes a changing part of an organism to effect alterations in other parts which are not at first implicated in or directly benefited by the original modification, and yet cannot help participating in it because the organism must alter more or less as a whole.

Thus, then, as amongst human beings, whether we consider the family or the race, similitude or family likeness implies blood-relationship or community of descent; in all organisms resemblances in structure which are constant in large groups or vary very slowly, imply origin from a common ancestor. The real problem of classification is nothing less than to group organisms as we should see them grouped if we could inspect the mighty family trees of the plant or animal worlds. This mode of regarding the facts of natural history is termed phylogeny.

In undertaking the actual task of classification, we proceed on the assumption that as in a tree the twigs which form the growth of any one year belong to branches of all ages—from the very earliest to the very youngest—the

[1] Notes of four lectures delivered at the Royal Institution during February and March.

[2] Darwin, "Origin of Species," 4th Ed. p 489.

living constituents of the vegetable kingdom represent, more or less modified, various successive grades of development which plants have passed through. Some of the branches of the family tree have now no living representatives, and as to these we must seek for such evidence as palæontology affords us. To trace out the family tree in all its details must obviously be always a matter of extreme difficulty, and may never be completely possible. Our present information does not extend to much more than

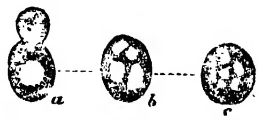


Fig. 7.—Successive stages in development of spores of yeast (after Re

a knowledge of the closely-packed exterior formed by the ultimate twigs. We cannot see very far how these pursue their course, nor get more than an approximate notion of the way in which the main branches are given off. Clearly, however, we may assume that organisms have in the main proceeded from simple and generalised forms to those which are specialised and complex. The simpler existing plants will therefore be the representatives of the oldest forms of all.

As long ago as 1836 Endlicher divided the vegetable kingdom into Thallophyta (leafless plants) and Cormophyta (leafy plants). The one exhibits the presence, and the other, if we may say so, the absence of the contrast of leaf and stem. Leafless plants are clearly the simpler, and come nearer, therefore, the base of the family tree.

Now Thallophyta have long been held to fall into two great groups—*Algæ* (tangles), which, speaking generally, are independent of organic nutriment, contain chlorophyll, and build up the materials of their tissues from inorganic materials; *Fungi* (thread-plants), on the other hand, are wholly dependent on other organisms, which they feed on, either living or in decay. Each series ranges from the very simplest forms which it is possible to conceive endowed with life, up to others which display a very complicated structure. Nevertheless there is a remarkable structural parallelism between them, and it

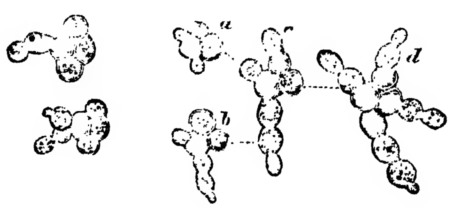


Fig. 8.—Germination of yeast-spores (after Reess).

seems probable that the Fungi do not possess a continuous line of descent of their own, but that they are an assemblage of reduced or degraded forms which have abandoned the business of food-manufacture, and appropriate their nutriment more or less ready made, and which correspond to different points in the line of descent of Algæ. *Thallophyta*, therefore, disregarding the cross division into Algæ and Fungi may be classified after Sachs,[1] and mainly according to their reproductive processes into four classes:—1. Protophyta; 2. Zygosporeæ; 3. Oosporeæ; 4. Carposporeæ.

PROTOPHYTA consist of excessively minute plants only visible to the naked eye when aggregated together in considerable masses. They consist of minute particles of protoplasm often no larger than a human red blood-corpuscle or much smaller, which are usually invested with a covering of cellulose, sometimes, however, very hard to distinguish. The protoplasm is homogeneous and without a denser portion or nucleus, but may contain minute particles, and even watery globules. It is either quite colourless or contains chlorophyll more or less masked with other colouring matters. Multiplication is effected by the fission or bi-partition of the protoplasm of one individual or cell. This frequently takes place in a single direction only, so that the new individuals more or less adhere together in a linear series. The cellulose investment or cell-wall is apt to pass by the absorption of water into a gelatinous condition, which may even form a kind of matrix in which the individual cells seem to be imbedded. Two groups deserve especial attention, *Schizomycetes* and *Saccharomycetes*. Both are destitute of chlorophyll, and so are dependent for their nutriment on materials elaborated by other organisms. In obtaining what they want they set up incidental chemical changes and decompositions. Thus Bacteria bring about *putrefaction* in fluids containing nitrogenous matters, and yeast produces *fermentation* in saccharine solutions.

Fig. 9.—Formation of spores of *Mycoderma vini* (after Cienkowski).

When any fluid capable of undergoing putrefaction is exposed to the air at a temperature of about 30° C., it speedily loses its clearness and becomes turbid and milky. This is usually due in the case of vegetable infusions to the presence of immense numbers of a minute organism known as *Bacterium Termo*. Other forms are, however, met with, and according to the nature of the fluid, one or other seems to get the upper hand and predominate. They vary in shape from a mere rounded speck ($\frac{1}{50000}$ in. in diameter) to elongated rod-like bodies sometimes rolled into a short spiral. The rod-like forms exhibit free movements which in the larger are obviously due to the presence of a cilium at each extremity, and are probably so in all.

The life history of the Bacteria is still imperfectly known. One striking kind has been studied from macerating pans by Prof. Lankester. It exhibits a great variety of forms, but all are tinged with a peculiar purple pigment, and it seems probable, therefore, that they all belong to the same species, and that the different phases are due to diversities in the condition of development or culture. This, if true, would apply to other series of forms which are colourless or tinged with other pigments. In one condition the Bacterium is in a kind of resting condition (Fig. 1), and is a mere microscopic spherule of protoplasm. This gradually granulates (Fig. 2),

[1] [illegible] Botanik, 4th ed., pp. 248-249.

and the protoplasm aggregating about the new centres, the spherule by successive stages (Figs 3 5) reaches a condition in which it forms an assemblage of individuals held together by their gelatinous investments These aggregates break up, and the individuals disperse Their subsequent degree of elongation varies, but a biscuit-shaped form is a common one Like other Bacteria they divide repeatedly, and ultimately accumulate in masses at the bottom of the fluid or on the surface in reticulated arrangements (Fig. 6), which are sufficiently permanent from the adhesion of their gelatinised coats (Zoogloea stage) The parallelism which these processes possess with those of higher forms of Algæ will be alluded to hereafter The whole of the *Schizomycetes* or *Bacteria* appear to be reduced representatives of the *Oscillatoriaceæ*, a group of Protophyta which possess the chlorophyll which Schizomycetes have lost They have, in addition, a peculiar bluish tint, and this may be recognised in Bacterium Termo

The *Saccharomycetes* must be dismissed very briefly. Yeast (*Saccharomyces cerevisiæ*), consisting of pale spherical cells about [1] in in diameter, is the type of the group, and multiplies, not like Bacteria, by fission, but by the budding out of new individuals from different points of the parent cell these often forming a short chain by repetition of the process, but being subsequently detached by constriction Under conditions unfavourable to growth, as when the yeast is cultivated on slabs of moist plaster of Paris, beside growth by external extension, there is also a process of internal segmentation of the protoplasm (first observed by Reess) These two modes of reproduction may be compared to the two which take place in *Protococcus pluvialis* The latter of these in the case of yeast results (Fig 7) in the massing of the protoplasm into four spores which are finally set free by the disruption of the parent cell wall They germinate when put into a favourable fluid, and reproduce chains (Fig 8)

The ferment of wine (*Mycoderma vini*), besides other points of difference produces cylindrical instead of spherical cells These also give rise to spores (Fig 9) by internal segmentation W T THISELTON DYER

(*To be continued*)

METEOROLOGY IN JAPAN[1]

EACH of the numbers of Mr McVean's publication gives the tri-daily observations of the various meteorological elements for five days, beginning with December 2, 1875, with the means and extremes for each of the five day periods The observations and reductions of each sheet have been made with great fulness and discrimination, and we hope Mr McVean will soon be in a position to extend his system of observation to more places than Tokei, so as to give the data for the determination of the meteorology of Japan, which, from its relations to the continent of Asia and ocean currents, presents many points of great and peculiar interest

The data discussed in Staff Commander Tizard's "Contribution to the Meteorology of Japan" have not been obtained through the observing staff of the *Challenger*, but from records lent by the Superintendent of Japanese Lighthouses and Buoys They consist of observations of the barometer, thermometer, rain gauge, wind and weather, as made at twelve lighthouses, two lightships, and at Yedo, the monthly averages of which are represented on four diagrams. The barometric and wind results are besides shown, by isobars and arrows, on twelve small maps for the different months of the year The Meteorological Committee publish, as an appendix to the paper, six closely printed pages of tabular matter, giving the results of observations made in the seas of China and Japan, deduced from registers kept for the Meteorological Office

The winds are, perhaps, the most valuable part of the paper, as showing the variations of wind with season at different places on the coast, they are, moreover, in general accordance with what was previously known of the meteorology of Japan The rain results are interesting, but they would have been more valuable if the position of the gauges had been stated From the necessarily faulty position of the thermometers, viz, "in the gallery outside the lantern in the air and shade" the averages of temperatures can only be regarded as roughly approximate Thus it is difficult to see how, if the mean temperature of July be 76 5 at Yedo, it is 86 6 at Nagasaki

The barometrical results can be regarded with nothing but astonishment In the winter months the mean pressure decreases from the isobar of 30 30 inches, which skirts the south coast to the isobar of 30 10 inches, which passes through the centre of Japan, the lie of the isobars being from about W S W to E N E With this distribution of pressure, all meteorological observation would lead us to expect the prevailing winter winds of Japan to be south westerly The observations, on the contrary, show the prevailing winds to be northerly, in other words, they are in direct opposition to Buys Ballot's law of the winds In summer the results are still more extraordinary In these warm months pressure increases from the sea coast inland From Yedo westward to Sikok, a distance of about 350 miles the lie of the isobars is from about W S W. to E N E the highest isobar being the most northern From this disposition of the isobars the laws established by meteorology would lead us to expect northerly winds Observation, however, shows on this part of Japan the prevailing summer winds to be southerly In this season, also Buys Ballot's law of the winds is violated

The discussion of this paper, therefore, teaches us that if we stand with our back to the wind in Japan, the low barometer is on our right, whilst everywhere else in the northern hemisphere from which we have observations the low barometer is to our left

But this is not all In August the mean pressure at 32 and sea level at Sagami (lat N 35 8, long E 139° 41) is 29 371 inches, and in the same month at Yedo (lat N 35 41, long E 139 47 the mean pressure is 29 931 inches These places which are about thirty three miles apart, have a difference in their mean atmospheric pressure for August of 0 560 inch, thus giving *a gradient in the mean pressure* in August of an inch in sixty miles So far as we are aware the steepest gradient yet noted at any time in this country was an inch in seventy two miles during the Edinburgh hurricane of January 24, 1868—a gradient accompanied with a wind which threw down solid masonry, and horses as if they had been "jointless pieces of wood" (*Jour Scot Met Soc*, vol ii p 177) Japan, however, presents us, in the above results, with an *average* summer gradient which, while it exceeds the *maximum* gradient attained during the Edinburgh hurricane, is accompanied only with delightful breezes as the prevailing summer winds of its coasts

Most meteorologists will perhaps be inclined with us to let their notions regarding aerial movements remain undisturbed till it appears whether these results may not have sprung from extraordinarily constructed or disordered instruments, or even, it may be, clever manipulations.

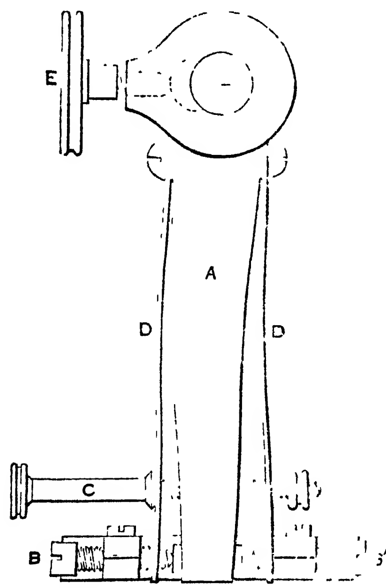
While allowing that the author of the paper, who does not appear to be familiar with what has been done in meteorology in recent years, has discussed the materials before him with some ability, we can only express our regret that the Meteorological Committee have authorised the publication of the paper in its present shape, and included

[1] Observations taken at the Imperial Meteorological Observatory Tokei Japan under the direction of C A McVean Surveyor in Chief Nos 1 to 23 — Contribution to the Meteorology of Japan by Staff Commander T H Tizard H M S *Challenger* Published by the authority of the Meteorological Committee, Official No 28

it among their twenty-eight publications marked "OFFICIAL;" and the more so inasmuch as its teaching directly tends to overturn the rules which guide seamen in storms and hurricanes, as well as the first principles of atmospheric physics.

GENTILLI'S TACHEOMETER

AMONG the instruments exhibited in the South Kensington Loan Collection is one likely to prove of great use in survey-making; it is the invention of M. Gentilli, an Austrian engineer, and its main purpose is to accomplish rapid surveys (hence its name) of difficult country. Not only does it survey the ground, but it gives the height and distance of every point surveyed. The instrument itself differs little from an ordinary surveying telescope. A vertical lever, A, is attached to the axis of the telescope by means of a screw, C (in figure); this lever moves the axis through a given angle, which can be exactly adjusted by means of the two stops, B B', opposite the free end of the lever. The points to be surveyed are marked by a surveying staff, on which are shown in a manner to be visible at a great distance, very minute divisions of a foot. The telescope is pointed to this distant staff of which it measures: (*a*) the horizontal angle of position, (*b*) the vertical angle of elevation, (*c*) the distance of the instrument from the staff. It is the accuracy with which this last



datum can be read that is accomplished by the peculiar mechanism of Gentilli's instrument. As an example: Suppose the staff marked with divisions, to have a scale of 12 feet, on which feet, inches, and eighths of an inch are shown. The telescope is directed to the top of the scale, of which it gives the horizontal and the vertical angle. It is next directed downwards by the screw to a fixed stop, and there it reads on the staff, say 10 feet 5 inches below the former reading; that distance on the staff is 1,000 eighths of an inch, and tells us that the staff is 2,000 yards off. In short, the greater the angle through which the telescope is moved, the greater the distance and *vice versâ*, Gentilli's telescope reading the distance and giving it exactly as read, without calculation of any kind. The mechanism is so precise that the telescope can be moved through any given angle and restored to its original position with almost perfect accuracy. Practice has shown that the distances so measured by a small instrument of only 40 magnifying power are correct to within $\frac{1}{2000}$ part. The instrument seems likely to be of the greatest use both to ordinary surveyors and to those who have to carry on extensive topographical operations.

THE RADIOMETER IN FRANCE

ALTHOUGH Mr. Crookes's apparatus was described in a few French papers at the end of last year, the novelty of the phenomenon has prevented physicists from paying due attention to it till within the last three months. But now the subject has been brought before the Institute and a number of experiments have been made or are being contemplated which are deserving of notice.

The first apparatus in Paris were procured from London, and also from Germany by Geissler; but now they are exported from Paris. There are in Paris not less than three makers—M. Gaeffe, M. Alvergniat, and M. Saleron—who are daily selling the apparatus, so that the instrument will soon become common in all laboratories in spite of the price, which is about 25 francs.

M. Fizeau, the well-known physicist, has stepped forward to defend the theory of air-dilatation. The most formidable objection was proposed by M. Ledieu before the Institute. This mathematician insists upon the great fact that in the air at the ordinary pressure the blackened plate is attracted instead of being repelled. He says that there is a decided opposition between these two phenomena, and that at a certain pressure the radiometer cannot move at all. I do not know whether the experiment has been actually tried. The best plan for investigating the question is to construct radiometers in different gases, carbonic acid and hydrogen, which I intend to do. If the rotation is produced merely by dilatation of the residual gas the motion must be quicker in hydrogen and slower in carbonic acid, owing to the difference of conducting power and mobility. But even then it remains to account for the inversion of rotation.

Sometimes the radiometer rotates in an opposite direction without any apparent cause operating upon it. In investigating the question I demonstrated very simply that this is because it emits heat. To obtain inverse rotation it is sufficient to leave it for some length of time exposed to the rays of the sun, or to the radiation of a furnace, and to plunge it in a vessel full of cold water. The effect is immediate, the inversion takes place almost instantly; but the real quantity of heat accumulated in plates being very small indeed, the inverse rotation is accelerated for a few seconds, and diminishes at a very rapid rate. In less than half a minute the radiometer stops, and direct action of the rays causes it to rotate again in the direct way if the vessel is of glass and transparent. The same experiment can be made in the shade, but it requires more caution, as the inverse action is less powerful, and the light can operate with sufficient force to continue the rotation in the normal direction, in spite of reverse force produced by refrigeration. But even in these cases it is possible to perceive a diminution in the rate of rotation. The radiometer falls to a rate which is smaller than the final one, and suffers a visible augmentation after a temporary diminution in the first instance.

M. Alvergniat exhibited, at a recent sitting of the Société de Physique, a double apparatus to demonstrate that the position of the blackened face determines the direction of rotation. The following experiments can be made with a radiometer with both plates blackened, and illustrate the same fact with greater simplicity if the half of the transparent sphere has been previously blackened.

If the blackened hemisphere is perpendicular to the rays, the radiometer will remain motionless; but in an oblique direction it will rotate to the left or to the right, according to the inclination of the incident rays. The least surplus in the quantity of light or heat received by any influenced surface will rotate the apparatus in the direction of repulsion.

M. Salcron made an experiment suggested by M. Ledieu, and which is a consequence of the fact above mentioned. If the light is received alongside the axis, the radiometer rotates. The velocity of the rotation is not yet in our hands.

The reflection of the light on the glass creates a disturbing force, as it is easy to show by the following experiment, which I made before the Academy of Sciences:— The bulb of an ordinary radiometer being half blackened, the rotation takes place in the same direction, whatever be the position of the blackened hemisphere, but at different rates. With the light falling on the white side, the rotation is reduced to about $\frac{1}{4}$, and about $\frac{3}{4}$ when falling on the blackened side. Both numbers give exactly 1, *i.e.*, the regular number of the translucid sphere. Consequently, I suppose the reduced rotation to be produced by the light reflected on the glass by the blackened surface, which light adds its effects to the light falling directly on the said blackened surface. This theory is in conformity with the well-known fact as stated by Crookes, that light A + light B gives one effect A + B, whatever be the respective situation of the lights on the circumference of a circle whose centre is the radiometer. I have no doubt that, by silvering the blackened hemisphere, which enlarges the reflecting power of the interior, the velocity of either rotation can be enlarged.

These remarks explain facts that, according to the dilatation theory, are a mere impossibility, the rotation in the same direction when a ray of light falls on the black or on the white side. These experiments can be made not only with a white or a black radiometer instead of alternate, but also with entirely transparent bulb, if light is predominant in one direction.

The difficulty in using the radiometer as a photometer is in the velocity of the revolutions. M. Gaiffe constructed for me a radiometer with a graduated screen which was in operation at La Villette Gas Works, and was sent to the lighthouse experimental establishment. Unfortunately that instrument requires a heliostat to send the rays into the aperture. Under that limitation the instrument works well, as the scale of proportion has been very easily established.

That reduction can be tried with a greater simplicity with a differential radiometer with plates differently coloured, the left with blue and the right with green or red. The rotation will be equal to the difference of rotating power, as demonstrated by the radiometer with both sides blackened. I suppose that white-blue + blue-black will give almost exactly the number of white-black, and that the rotating force might be so easily fragmentised. By a graduation all these different radiometers can be compared with each other.

Some of these radiometers are being constructed according to my suggestion by M. Gaiffe, and will be presented to the Academy as soon as the aforesaid theory shall have been demonstrated experimentally.

W. DE FONVIELLE

PROF. STEERE'S EXPEDITION TO THE PHILIPPINES

IT may interest zoologists to know that an American gentleman, Prof. J. B. Steere, of the University of Michigan, has recently returned from an expedition to the Philippine Islands, bringing with him large collections of natural history objects. The birds he has submitted to me, and I am now engaged in preparing a memoir on the collection, which seems to be one of the most important ever made in the Indo-Malayan Islands. In spite of the great difficulties which meet the traveller in the Philippine group, and notwithstanding severe attacks of fever, Dr. Steere exerted himself with great energy, and as he visited many islands in which no previous collection had ever been made, it is not surprising that many novelties occur in the one he has now brought over to England for description.

Leaving Hongkong for Manila, in May, 1874, Dr. Steere crossed the Island of Luzon by way of Mauban and Lucban to the Pacific, passing some time on the mountain of Ma-hay-hay, near the Laguna de Bay. In July he went by steamer to the colony of Puerto Princesa, on the east side of the Island of Palawan, where he stayed a month. From thence he crossed to the Island of Balabac and remained a month, afterwards visiting the south-east corner of the Island of Mindanao, and resting for a month and a half at Zamboanga and the Indian village of Dumalon in the same province. The Island of Basilan, lying between Mindanao and the Sooloo group, was next visited, and here he stayed two weeks, after which he returned to Zamboanga and thence to Manila. In the month of December he again went south, stopping at Ilo Ilo, on the Island of Panay, and visiting the mountains in the interior. After a short stay at the neighbouring Island of Guimaras he crossed over to Negros, journeying on horseback round the north end of the island; thence in a native boat he traversed the sea to Zebu, which he crossed, till he arrived at the town of the same name, where he took horse again and rode southward, crossing the island once more and passing over the strait to the town of Dumaguete, on the Island of Negros. Dr. Steere then went back to Zebu and crossed to the Island of Bohol; after passing round part of this island he returned to Zebu and afterwards to Manila, where he visited the Negritos on the north side of the Bay of Manila, leaving finally in April for Singapore.

Full descriptions of the new species will shortly be prepared, but meanwhile I cannot avoid drawing attention to one or two of the most remarkable forms, chief amongst which will be the following:—

Eurylæmus Steerii, Sharpe. Unlike any other member of the *Eurylæmidæ*, no species of which was previously known to inhabit the group. It has a grey back, white collar round the neck, the head and rump deep purplish, the tail chestnut; wings black with a yellow bar across the secondaries, white on the innermost; sides of face and throat black; rest of under surface white. The male differs in having the under surface purplish red. Hab. Basilan.

Phyllornis palawanensis, Sharpe, apparently different from every other *Phyllornis* by reason of its yellow throat, green under surface, and blue-edged primaries. There are other differences, but the above seems to be a combination of colouring not met with in the other species. Hab. Palawan.

Brachyurus Steerii, Sharpe. Green with a black head; shoulders and a band across the rump bright cobalt; tail black; below verditer blue or light cobalt, the throat white; centre of the abdomen black; vent and under tail-coverts crimson. Hab. Dumalon, Mindanao.

It is, however, among the sunbirds that Dr. Steere seems to have discovered the most curious novelties, as will be seen from the following birds:—

Æthopyga magnifica, Sharpe, resembles *Æ. flavostriata*, Wallace, from Celebes, but is larger, with a stronger bill, black belly, and is at once to be told by its black under-wing coverts. Hab. Negros.

Æthopyga Shelleyi, Sharpe, like *Æ. dabryi*, and *Æ. gouldiæ* in appearance, but without the elongated tail, and distinguishable at a glance by the entirely yellow under-surface, streaked on the breast with scarlet; the throat is yellow, bordered with a double moustachial line of scarlet and steel blue. Hab. Palawan.

Æthopyga pulcherrima, Sharpe, a small species, probably generically distinct. Above olive-green, with a steel blue frontal patch, and streak over the ear-coverts; wing-coverts, upper tail-coverts, and tail, metallic steel-green; rump yellow; wings olive; under-surface entirely

bright yellow, with a spot of vermilion on the lower throat. Hab. Basilan.

Arachnothera dilutior, Sharpe, resembles *A. longirostris*, but is distinguishable by its brown lores and by the ashy whitish colour of the entire under-surface, only the flanks being slightly washed with sulphur-yellow; pectoral tufts orange-yellow. Hab. Palawan.

Dicæum dorsale, Sharpe. Looking at first sight like *Prionochilus percussus*, Temm. Blue-grey above with a conspicuous dorsal patch of orange-scarlet; underneath orange, paler yellow on the throat and abdomen. Hab. Palawan.

Dicæum hypoleucum, Sharpe, of the same group as *D. retrocinctum*, Gould, but plainer coloured, being entirely black above, and entirely white below (♂). Hab. Basilan.

Dicæum hæmatostictum, Sharpe, also of the same group as the preceding. Black above, white below, the centre of the body bright crimson, with a black band across the fore-neck. Hab. Guimaras.

R. BOWDLER SHARPE

SCIENCE IN GERMANY

(*From a German Correspondent*)

CIENKOWSKY, who several years ago made some exceedingly interesting communications on the low organisms known as Monads (*Archiv für Mikroskopische Anatomie*, i. 1865), has recently contributed more additional information regarding them and allied organisms (*ibid.*, xii. 1875). To the lowest order of plants belong the Myxomycetes, which, in the complete state, form protoplasmic nets, named plasmodia. Cienkowsky found such plasmodia in fresh water, which fed themselves by suction of algæ; on passage into the resting state, they fell asunder into several cysts, and (what is deserving of special attention), by the release of small portions from their mass, produced amœba, *i.e.*, self-supporting individuals, which creep about by means of pseudopodia, and which have hitherto been regarded as independent animal organisms. As this phenomenon has also been observed in other plasmodia (Brefeld), it is not improbable that very many amœba do not represent independent forms, but belong to the development cycle of other and plant-like forms. *Ciliophrys infusionum*, an organism which stands very near the animals named Actinophrys, is transformed while under the covering glass, into a swarmer (swarmspore), and when several individuals are connected, or one enters on the process of division, there arise as many swarmers as there were parts. Through this formation of swarmers there appears Heliozoa, which group belongs to the Actinophrys, closely related to Monads, or those lowest organisms which have been claimed both by zoologists and botanists as objects belonging to them. Among the Monads, Cienkowsky observes various encystments, divisions, and colony formations; but the most remarkable of such processes is that in *Diplophrys stercorea*, an extremely small cell-like organism with a yellow spot, and pseudopodia at two opposite ends of the body. These little bodies, observed in moist horse-dung, multiply by division, and form by union of pseudopodia, long strings in which separate individuals can glide to and fro. In several of the organisms he examined, Cienkowsky was able to observe the taking up of solid food by suction of algæ. Thus the boundary lines, which it has so long been usual to draw between plant and animal organisms, and between the individual groups of those lowest forms of life, appear more and more illusory, and the supposition is recommended of a common lowest kingdom of organisms, that of Protista (Haeckel), out of which animals and plants have by degrees been differentiated.

The Amphioxus, that remarkable animal which, by its position at the lower end of the series of vertebrates, is become much better known, even among the laity, than most of the other vertebrates, enjoys no less the continual attention of anatomists. Among the various recent works which have had Amphioxus for their subject, one of the most comprehensive is that of Langerhans (*Archiv für Microsc. Anatomie*, xii. 1875), from which I take some generally interesting data. The Amphioxus, it is known, is so indifferent in the fore-end of its body that opinions as to the extent to which it is to be regarded as a head, and what parts of it are to be compared to the characteristic parts of the head in other vertebrates, are still ever at variance with each other. Especially does the fore-end of the central nerve system receive various explanations, and Langerhans has set himself to determine more precisely its anatomical relations. The entire central nerve-system is a regular tube which only at the fore-end is somewhat enlarged. This part, therefore, has been named the brain, but it has been compared now with this, now with that, part of the brain of other vertebrates, according to the determination of the nerve proceeding from it. Now Langerhans shows that from the brain proceeds one pair, and somewhat further back a second pair, of nerves, which are distinguished from all other peripheric nerves, in that some ganglion cells are interposed in their course. They can only, therefore, be denoted as special brain nerves. Further, there is the left side extremity of the brain in front, the point of which is connected with the olfactory cavity, and which, as a hollow prolongation of the brain, can only be compared to a bulbus olfactorius, while the pigment spot referred to as an organ of sight lies also not outside of the brain (Hasse), but in its front wall (W. Muller). The fore-end, accordingly, of the central nerve-system of the Amphioxus, as far as behind the roots of the second nerve pair, is to be compared with the entire brain of other vertebrates, not with separate parts of it. Further, of the two higher organs of sense of the amphioxus, the organ of smell is allied to that of other vertebrates, the organ of sight to that of the Ascidians, whereby the relation between these latter, the Amphioxus, and the vertebrates, is confirmed. As to the significance of the body-cavity of Amphioxus, Langerhans is not yet very clear, and only the history of development can give satisfactory information regarding it. He found, however, that in this cavity lie not only the organs of sex, but also excreting glands, which may be regarded as kidneys; so that the space appears, at least physiologically, as the ventral cavity. Those glands which F. Muller had already observed, occur in peculiar folds of the epithelium of the ventral cavity, so that the excretion takes place directly into this cavity; a structure which is repeated at least in the embryonal organs of excretion of Amphibia (Goette). The sex organs of the Amphioxus are at first quite similar for both sexes, and placed indifferently; they arise from a thick-walled bladder, composed of quite homogeneous cells in the wall of the ventral cavity. At the time of sexual maturity, these indifferent cells are transformed either into semen-forming elements, spermatoblasts, or simply grow into eggs. Langerhans met with both sexual products in the same organ, so that perfect homology of these is established for Amphioxus, as Goette and Semper have previously affirmed it for Amphibians and Selachians; and the hypothesis of hermaphroditism as the original form of the sex organs must be rejected. After demonstrating for some other organs and tissues, the agreement of the amphioxus with other vertebrates, especially with Cyclostoma (and the hitherto doubtful presence of blood-capillaries in the former is confirmed), Langerhans comes to the conclusion that, in opposition to the view advocated by Semper, who disputes the affinity of Amphioxus to the vertebrates, such an affinity appears indubitable, from most of the anatomical relations.

NOTES

A NUMBER of highly interesting excursions has been arranged in connection with the meeting of the French Association at Clermont. One day will be devoted to a visit to the argentiferous lead-mines of Pontgibaud, the lavas of Volvic, the town of Riom. There will be a second excursion to Issoire, "celebrated for its college and its caldrons," wrote Voltaire; there will be a visit to the grottoes of Sonas on the same day. There may also be a third excursion to Thiers, the cutlery and paper manufactures of which are of interest. A last excursion, consisting of a visit to the thermal stations of Mont-Dore, Bourboule, and St. Nectaire, has somewhat tried the ingenuity of the local committee, as it will be difficult to get conveyances enough to carry the members to these somewhat distant points. But no doubt, as we said last week, the great attraction of this meeting will be the inauguration of the observatory on Puy-de-Dôme, which amid many difficulties has been established by M. Alluard. From the elevated summit, 1,480 metres, may be seen the fertile Limagne, the hills of Forez, the peaks of Mont Dore, and all

the chain of the extinct craters of the Dôme Mountains, which run from south to north, having Puy-de-Dôme in the centre.

THE livery of the Musician's Company, with the freedom of the City of London, was appropriately conferred on Sir Henry Cole, at the dinner on Tuesday. In presenting the honour, the Master, Mr. William Chappell, F.S.A., traced Sir Henry's career with deserved appreciation. Sir Henry was educated at Christ's Hospital. His first public service was as assistant-keeper of the Public Records, where he paved the way to the establishment of the General Record Office. A second public service was the energetic assistance rendered by him to the establishment of penny postage. He gained one of the four prizes of 100*l.* offered by the Treasury for suggestions to develop Sir Rowland Hill's plan, and continued his aid to Sir Rowland until his object was fully attained. He had himself accepted the office of Secretary to the Mercantile Committee on Postage, and was thus instrumental in furthering the success of a measure which he had helped to carry. Sir Henry's services to Art and Science in this country are well known to every one. The exhibitions of art manufactures which commenced about the year 1846, at the rooms of the Society of Arts, were projected and organised by Sir Henry Cole. These annual displays were designed to lead to national exhibitions of arts and manufactures every fifth year. The first of this series would have taken place in 1851, but the plan was developed into the great exhibition of that year. Mr. Cole was one of the executive committee of that famous and most successful exhibition, and received the honour of Companionship of the Order of the Bath at its conclusion. In the following year he was invited by the Government, through Earl Granville, to improve the system of the schools of design, and he was thus instrumental in establishing the Science and Art Department, of which he was at first senior secretary, and afterwards inspector-general. To the pecuniary success of the great exhibition in Hyde Park, which sprang out of Sir Henry Cole's projection of one of more limited character, we are, as we showed in a recent article, mainly indebted for the present magnificent establishments at South Kensington. In 1860 Sir Henry was appointed General Superintendent of the South Kensington Museum, and also acted as Secretary of the Science and Art Department, under the Committee of Council on Education. In this capacity we know that he created, or was directly responsible for, the system of Science and Art Schools which by general consent are acknowledged to have done so much good already for the country. In 1873 he retired from office at South Kensington, after fifty years of public service. Sir Henry's services were acknowledged by her Majesty in conferring on him the rank of Knight Commander of the Bath about two years after his retirement. The last honour which has been conferred upon him is most appropriate, as we have said, and assuredly well deserved.

ON Tuesday a deputation from the British Medical Association waited on the Home Secretary for the purpose of laying before him several resolutions recently passed unanimously at a meeting of the medical profession in London. On behalf of the deputation Dr. Hutchinson handed in the following resolutions:—1st. Proposed by Dr. Andrew Clark and seconded by Dr. Pavy, "That this meeting, although fully recognising the improvements in the Bill of Lord Carnarvon, is still strongly of opinion that should it become law the progress of science would be most seriously hindered, and the interests both of animals and man much prejudiced." 2nd. Proposed by Dr. Barnes, and seconded by Dr. Wm. Adams—"That this meeting would urge upon the promoters of the Bill that legislation on this subject should be abandoned for the present session." 3rd. Proposed by Dr. Stewart, and seconded by Mr. Ernest Hart—"That in the event of its being thought necessary for proposed legislation in the future, this meeting would suggest, as an alternative measure, first an Act for the simple registration of persons licensed, and secondly by the Act dealing with the whole subject of cruelty to animals." Mr. Cross accepted the resolutions in question, and thanked the deputation for the expression of their views. A long and technical discussion on the various clauses of the Bill ensued between the Home Secretary and the deputation.

EARLY this year there was organised at Boston, U.S., an "Appalachian Mountain Club" for the advancement of the interests of those who visit the mountains of New England and adjacent regions, whether for the purpose of scientific research or summer recreation. The Club will carry on a systematic exploration of the mountains of New England and adjacent regions, publishing its results from time to time, and will collect books, maps, photographs, sketches, and all available information of interest or advantage to frequenters of the mountains. It will also encourage the opening of new paths, clearing of summits from which views may be obtained, and other improvements. At the same time the Club will encourage the study of comparative geography in general, opening its meetings to contributors on zoological and botanical geography, geology, topography, hydrography, travel, and exploration. The Club is divided into five sections or departments of work—Natural History, Topography, Art, Exploration, Improvement, each with its superintending "Councillor;" Prof. Sterry Hunt is Councillor in Natural History, while the President of the new Society is Prof. E. C. Pickering. The publications of the Club will be very comprehensive and exhaustive; under the title of *Appalachia*, the first part of its journal lies before us. It is mostly occupied with details connected with the formation of the Club, but also contains some interesting papers already read at the meetings. Among these we may mention a paper by Prof. C. H. Hitchcock on the "Atlantic System of Mountains;" another by Mr. S. W. Holman on "Two New Forms of Mountain Barometer," and a third on "A New Map of the White Mountains," by Mr. J. B. Henck, besides the reports of the Councillors for the spring of this year. Altogether great things may be expected from this new club. The Secretary's address is the Massachusetts Institute of Technology, Boston, Mass.

THE "Results of the Meteorological and Magnetical Observation for 1875" at Stonyhurst College Observatory, gives very complete summaries of the monthly means and extremes, which are made more valuable by being compared with the results of the past twenty-eight years. To these summaries is appended a discussion on the hours of occurrence of the daily maxima and minima of temperature. As regards the maxima, the mean for the year is 2 P.M., the monthly extremes being mid-day in December and 4 P.M. in June and July. On the other hand, the minima show two maximum periods of occurrence, one from 4 to 5 A.M., and the other at midnight. The excessively frequent occurrence of the lowest night temperature at midnight, which is given at 747, whereas the largest number for any other hour is 307 at 5 A.M., and the double period of the curve (Plate I.), not being in accordance with the physics of the question, suggest that a faulty method of discussion has been adopted. Evidently, as regards both maxima and minima, each daily period of twenty-four hours has been considered as beginning at midnight, whereas each daily period for the minimum temperatures should extend from mid-day to mid-day. Hence the unsatisfactoriness of the discussion, the only remedy for which is to begin the day, as regards the maximum temperatures, at midnight, thus including in each day the whole time the sun is above the horizon; and as regards the minimum temperatures, at mid-day, so as to include in each day the whole time from sun-down to sun-rise.

WE learn that the Circular of the Committee of the R.A.S. requesting drawings of Jupiter to be made at southern observa-

tories during this year has been efficacious in America at least. M. Trouvelot, who has given much time to the production of astronomical drawings has already secured no less than thirty-four drawings during June. This is important, as Dr. Oswald Löhse, who is studying the surface of Jupiter carefully, declares the changes this year to be of exceptional interest.

In the *Bulletin International* of the Paris Observatory for July 14, Prof. Raulin gives a supplement to his valuable paper on the distribution of the rainfall of Algeria, which was published some years ago, based on fifty-five series of observations brought down to the close of 1874. The mode of the distribution of the rainfall of Algeria is much less varied than that of the south of France, for while in the south of France there are six distinct rain-regions, in Algeria there are only two, the one region being characterised by a very dry summer and a very wet autumn and winter, embracing the less elevated land near the shore and the northern borders of the Hauts-Plateaux; and the other region characterised by a very rainy spring and dry summer, including the Hauts-Plateaux with their borders which skirt the Sahara.

We have received the *Meteorologische Beobachtungen* made thrice daily at the Observatory of the Leipsig University under the direction of Dr. Bruhns during 1875, the whole being carefully reduced, and copious footnotes given each month of the more marked phenomena. The method of publishing only the readings of the dry-bulb and the hygrometric deductions is faulty. All such publications ought to include at least both of the observed facts, viz., the readings of the wet bulb as well as those of the dry bulb.

A fall of meteorites, we learn from *Aftonblad*, took place on June 28, between 11 and 12 A.M., near Stalldalen, a station on the Swedish Central Railway, in the northernmost part of Orebro-lan. Several fell, some on the ground and others in a lake. Two were found, one about the size of the fist and weighing 4½ lbs., the other smaller. Eye-witnesses stated that a loud whistling was first heard in the air from west to east, and a light was plainly distinguishable; although the sky was clear and cloudless, thereafter two very sharp reports were heard, the second succeeding the first after a momentary interval, followed by several others less sharp, resembling thunder, after which the falling stones were observed by eight or ten persons; and finally, there was seen in the air a whirling smoke, not very high up. A meteor was observed simultaneously at Stockholm and at other places. At thirteen English miles south-west of Linkoping it was seen first in a north-westerly direction pretty high up in the sky, and it then sank down in about ten seconds towards the horison in the west. It had the appearance of a large pear a foot long, which, notwithstanding the bright sunshine, left behind a clear shining streak of six or eight feet in apparent length, which finally broke up into a multitude of starlike sparks. Here no noise was heard. According to a communication from the Stockholm Meteorological Bureau, there is reason to believe that the phenomena arose from the "kulblixt" (*foudre globulaire*), which generally appears as a luminous round object, and often, on approaching the ground, assumes a lengthened form and a blinding white colour, and bursts asunder, commonly with a loud report. As all who observed the meteor, both in Stockholm and in Södermanland, saw the luminous appearance in the same direction, viz. W.N.W., it is probable that the light proceeded from the main mass of the meteor situated at a very great distance. The phenomenon observed here (at Stockholm) must therefore have been so far an illusion, the object, instead of being, as most people estimated, within a few thousand feet, being actually at a great distance. Later information shows that the phenomenon was visible over a great part of middle Sweden.

The most interesting article in Heft 7 of Petermann's *Mittheilungen* is on the present Turko-Servian war in its ethnographic and historical bearing. The various and very varied elements that go to make up the population over which the Sultan holds sway are pointed out, as well as the fact that the war is not one between Turks and non-Turks, but between Mohammedans and Christians, and especially Christians of the Greek Church. It is thus not a war of races, as many seem to think, a struggle on European ground between Aryans and Turanians, but a religious war, Mohammedanism not being confined to people of Turkish origin. An excellent map to illustrate the various data given in the paper, accompanies the part. There is an article on the geography of the region around the mouths of the Ob and the Jenisei, founded on the information obtained by Nordenskjold's expedition of last year, of which an account appeared in Nature; this article is also accompanied by a map. Another article describes Largeau's second expedition to Rhadames. Dr. Schweinfurth contributes an account of the expedition conducted by himself and Dr. Gussfeldt to the Arabian Desert from the Nile to the Red Sea, as also of Dr. Ascherson's journey to the Little Oasis (Wah-el-Bah'rieh) in March May, 1876. In an article on the "Solution of the Question of the Nile Sources," Dr. Behm refers to the recent circumnavigation of Lake Albert Nyanza by Signor Gessi, and maintains that it is now proved that the true sources of the Nile are Lakes Albert and Victoria, and that therefore the glory of the finding of this ancient quest belongs to the late Capt. Speke along with his still living companion, Col. Grant. Among the Geographical Notices is a paper by Dr. Hann, on "Certain Important Irregularities of the Sea-level."

From the "Ninth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology" (Cambridge, U.S.), we learn that the trustees have resolved to proceed with the erection of a museum building worthy of the magnificent collection they possess. The most important addition to the museum during the year, probably the largest donation ever made to the museum, is that from Peru and Bolivia, collected by and at the personal expense of Mr. Alexander Agassiz. This collection is of great importance in relation to South American archæology and ethnology. Other additions have been made from various parts of America. A General Index to the nine Annual Reports accompanies the present one.

M. Largeau and M. Louis Say are about to undertake another expedition into North Africa; the goal of the former this time will be Timbuctoo, and of the latter Ahaggâr, the culmination of the Central Sahara, and which, it is said, has not hitherto been visited by any European.

In a recent communication to the French Geographical Society, M. Alph. Pinard announced the discovery of a great number of tumuli, quite different from the shell-mounds, on the south and south-east coast of Vancouver Island, which he has been exploring for some time. Out of one he obtained a skeleton with a much deformed head.

The Vienna papers report the death of Mdme. Hubenstein, a lady who had been maid of honour to Maria Theresa, and lived to the extraordinary age of 119 years. The case ought to be noted as being well authenticated and not grounded merely on idle rumour.

The number of visitors to the Loan Collection of Scientific Apparatus during the week ending July 29 was as follows:—Monday, 3,263, Tuesday, 2,660; Wednesday, 514; Thursday, 459; Friday, 508; Saturday, 3,880; total, 11,284. The usual lectures and demonstrations are given during the present week.

The statue of M. Elie de Beaumont will be inaugurated at Caen (Calvados) on the 6th inst. The ceremony will be interesting, as a deputation from the Institute will be present to do honour to the late perpetual secretary.

THE Senate of the French Republic having rejected the law proposed by the Government and adopted by the Legislative Assembly for conferring honours on students, a mixed jury has been appointed to give diplomas to the pupils of Catholic universities. This body will sit in the Salle Gerson, close to the Sorbonne; the Session will begin next week. The number of candidates is very limited owing to the failure of the new universities.

DR. B. W. RICHARDSON'S proposal for a "City of Health" (the *Times* states), mooted by him in the autumn of last year, is about to be tried practically. A site has been secured on the coast of Sussex, where the sanitary city will be laid out and in due time erected. Dr. Richardson has given his countenance to the scheme, and will supervise the sanitary arrangements, while Mr. Frank E. Thicke will be responsible for the architectural details.

THE Annual Meeting of the British Medical Association commenced on Tuesday at Sheffield, under the presidency of Dr. de Bartolomé of that town.

M. UJFALVY has been entrusted by the French Minister of Public Instruction with a scientific mission, having for its object ethnographical, linguistic, and historical researches in Russia and Central Asia. M. Ujfalvy proposes to set out early this month for St. Petersburg; from thence he will go to Moscow, Nijni-Novgorod, Kazan, and Irkutsk. He proposes also to descend the Volga to the Caspian, and with permission of the Russian authorities to penetrate into Turkestan and the Khanate of Khokand, and as far as Kashgar, returning by southern Siberia.

THE fifth Annual Exhibition of Industrial Arts was opened at the Palais de l'Industrie, Paris, on August 1. This exhibition is remarkable for the large number of historical pictures representing the appearance of Paris at different dates. Each year the several schools of design established by the municipality in different places hold a special exhibition. A great improvement is said to have been noted this year.

SOME French departments are creating agricultural professorships to be paid at the expense of the local budget. One of these has been established by Vienne, one of the most advanced departments in meteorological organisation. The professor will be appointed by competition. He will have to teach the pupils of the normal primary school and to deliver lectures at a number of rural localities. The salary is to be 190*l.* irrespective of special allocations and travelling expenses.

THE additions to the Zoological Society's Gardens during the past week include two Tigers (*Felis tigris*), two Indian Leopards (*Felis pardus*), an Indian Elephant (*Elephas indicus*), two Indian Antelopes (*Antilope cervicapra*), two Horned Tragopans (*Ceriornis satyra*) from India, presented by H.R.H. the Prince of Wales; two Ringed-necked Parrakeets (*Palæornis torquata*) from India, presented by Mrs. Dovat; an Anubis Baboon (*Cynocephalus anubis*) from West Africa, two Australian Crows (*Corvus australis*) from Australia, received in exchange; an Axis Deer (*Cervus axis*), four Chilian Pintails (*Dafila spinicauda*), four Common Teal (*Querquedula crecca*), two Crested Guinea Fowls (*Numida cristata*), bred in the Gardens.

SCIENTIFIC SERIALS

Journal of the Chemical Society, May.—Mr. Francis Jones, F.R.S.E., contributes a paper on stibine. Mr. Jones has investigated several methods of producing this gas, and the one which commends itself to him as the most convenient is the following. A strong solution of antimony in hydrochloric acid is allowed to drop on a considerable bulk of zinc, either granulated or in powder. The resulting gas is then purified by passing it through a very dilute solution of caustic soda, and subsequently dried over calcium chloride and phosphoric anhydride.—Dr. Paul von Hamel Roos gives a paper upon crystallised glycerine. The solidification of this body seems to depend upon the entire absence of water or any other impurity. Dr. Roos is carrying on further investigations with this interesting compound.—Messrs. Beckett and Wright contribute a paper on the action of the organic acids and their anhydrides on the natural alkaloids.—A paper on the use of platinum in the ultimate analysis of carbon compounds, by Mr. Ferdinand Kopfer, of Owens College, Manchester, is the last of the papers read before the Society which appears in this number.—The usual extensive collection of abstracts from papers in British and foreign journals occupies the remainder of this number.

Journal of Mental Science, July.—An article on Kalmuc idiocy is contributed by Dr. John Fraser, with notes of cases by Dr. Mitchell.—In an unsigned essay on John Howard—curious as an application of the necessitarian doctrine to the estimate of character—there is a persistent attempt to depreciate the moral grandeur of the great philanthropist, and to show that his labours have borne much evil as well as good fruit. The essay is accompanied by notes written in an opposite spirit.—Dr. Claye Shaw on the measurement of the palate in idiots and imbeciles, gives evidence that there is no necessary connection between a high palate and the degree of mental capacity of the individual, and that it is difficult to see of what service a palatal investigation can be in affording a clue to the mental faculties.—A very interesting antiquarian and topographical account of the Bethlem Royal Hospital from the year 1247 is given by Dr. Hack Tuke.—Dr. J. A. Campbell presents notes on the reparative power in insanity.—The plea of insanity as set up in two cases of murder is discussed by Dr. Yellowlees, and the difficulties and delicacies of the subject are well brought out.—In an important correspondence between Dr. Bucknill and Dr. Clouston on the relations of drink and insanity, Dr. Bucknill gives his views at considerable length.—An Arab physician on insanity; clinical notes and cases; four neat little reviews of books; the psychological retrospect, English, German, American; with notes and news make up the number.

Sitzungsberichte der Naturwissenschaftlichen Gesellschaft Isis in Dresden, January to June, 1875.—We note, in the Botanical Section, some observations by Prof. Nobbe on root formation of seed plants The *rôle* of roots being the conveyance of water and mineral matters, and the amount of this depending, *cæteris paribus*, on the extent of surface of young root fibres, he set himself to ascertain this extent in different plants in relation to the surface of the green organs. Plants of Scotch fir, spruce fir, and silver fir, were so grown, that all the root fibres could be collected without loss. The first year's root-product of the Scotch fir (about 12 inches long) exceeded that of the spruce fir about six times, and that of the silver fir about twelve times. The surfaces of the organs above ground were, to those of the subterranean organs, in the Scotch fir as 100 : 477; in the spruce fir as 100 : 168; in the silver fir as 100 : 169. (The entire surface of the first year's plants were respectively, in the order just given, 24,820, 5,690, and 3,903 sq. mm.) It is thus seen how the Scotch fir thrives on sterile, sandy ground, where spruce fir and silver fir perish; also the difficulty of transplanting the Scotch fir may be understood, for a considerable portion of the root is apt to be left in the ground, and the plant does not recover from the loss, nor reproduce the fibres readily.—The geological department contains descriptions of the geology and mineralogy of Vigsnoes in Norway, and of the Kaiserstuhl in Breisgau, Baden.

Jahrbuch der Kaiserlich-königlichen geologischen Reichsanstalt Wien.—In the third and fourth parts of this valuable scientific journal, published during the last six months of 1875, there are a number of articles of very considerable scientific interest. Among the papers on geology, that by Dr. Woldrich, on the old gneiss formation of a part of the Bohmerwald may be noticed as especially worthy of attention; and the same may be said of the memoir which Doelter and Hoernes contribute on the subject of the origin of dolomites, bearing especial reference as it does to the remarkable and well-known rocks of this class in the Southern Tyrol.—The excellent palæontological papers by Dr. Hoernes and MM. Herbich and Neumayr respectively, throw fresh light on those extensively developed tertiary deposits of Eastern Europe, the study of which is, in the hands of the Austrian and Hungarian geologists,

yielding so many interesting and striking results.—The *Mineralogische Mittheilungen*, which, under the editorship of Dr. Tschermak now forms such a valuable portion of the *Jahrbuch*, contains an article by Dr. Hirschwald "Zur Kritik des Leucit-systems," which is sure to be eagerly read, now that so much attention has been excited on this question by the memoirs of von Rath and Scacchi.—Dr. Brezina's contribution to the question of isomorphism, especially in its bearing on the classification of the felspars, is not yet completed, but promises to be one of great importance and suggestiveness.—Dr. Drasche, who, on his way to the Malay Archipelago, whither he is gone to study the volcanic phenomena of that area, has visited the island of Bourbon, sends home an interesting communication concerning its geology, which is also published in the *Mineralogische Mittheilungen*.

Gazzetta Chimica Italiana, Anno vi. 1876, fasc. iii.—A considerable portion of this number is taken up by an account of the researches of E. Paterno, of the University of Palermo, on usnic acid as derived from *Zeora sordida*. His investigations induce him to adopt the formula $C_{18}H_{16}O_7$ in preference to those adopted by Stenhouse, Hesse, and others who have interested themselves in this body. In deriving usnic acid from the above source, the investigator discovered two new substances which were invariably present, although in exceedingly small quantities. To these he has given the names zeorin and sordidin (zeorina e sordidina), and assigned the formulæ $C_{14}H_{22}O$ to the former, and $C_{16}H_{18}O_7$ to the latter.—G. Koerner contributes a paper on the constitution of veratric acid and veratrol. The same investigator, conjointly with G. Monselise gives an interesting account of two benzol-bisulphuric acids, and of their relations with other compounds.—In addition to the foregoing, an extract from an account of Prof. F. Selmi's research on atropine is given, and a paper by R. Schiff on the product obtained by bringing into contact with each other acetylic chloride and acetic aldehyde.—F. Sestini furnishes a paper on ethyl santonate, and a few extracts from other chemical journals complete this serial.

Journal de Physique, April.—M. Cazin here gives an outline of his recent researches on the thermal effects of magnetism. The three methods are described by which he measured the calorific effects produced in the core, also his mode of measuring the magnetic quantities, with the electrodynamic balance. In the case of a bi-polar tubular core, the quantity of magnetism alone being varied, by changing the intensity of the current, the quantities of heat generated by intermittences of the current are proportional to the squares of the quantities of magnetism alternately gained and lost by the core. The polar interval alone being varied, by altering the length of the core, the quantities of magnetic heat are proportional to the polar intervals, and consequently to the magnetic moments. In the case of a multi-polar tubular core, the successive polar intervals being equal, the quantities of heat generated in the core by the same interrupted current are inversely proportional to the squares of the number of intervals.—The Bureau des Longitudes decided in May last year to rectify annually the Magnetic Map of France; and in this number are shown the isogonic lines, degree by degree, as deduced from last year's observations. There is also a table of the principal towns in France, with the declination and annual variation for each.—A note by M. Potier treats of the conveyance of luminous waves by ponderable matter in motion.—We further note an abstract of researches by MM. Angström and Thalen, on the spectra of the metalloids. They affirm that carbon has only one spectrum, a spectrum of lines; the other spectra attributed to it are due to compound bodies. The same with nitrogen.

SOCIETIES AND ACADEMIES

London

Geological Society, June 21.[1]—Prof. P. Martin Duncan, F.R.S., president, in the chair.—12. On the mechanism of production of volcanic dykes and on those of Monte Somma, by R. Mallet, F.R.S. The author stated that in 1864 he made a careful trigonometrical survey of the escarpment of Monte Somma, especially with reference to the numerous dykes by which the rocks composing it are intersected. He described in detail the phenomena of direction of the dykes, especially as regards the axis of the cone of Vesuvius; to this direction he gives the name of *orientation*. Of twenty-seven dykes ten presented an approximately vertical line, whilst all the rest had a sensible dip or "hade." The dykes are in no cases intersected by coherent beds of lava, but in one instance the top of a dyke was stopped by such a bed. Many of the dykes bifurcated or branched, and frequently two dykes intersected each other at considerable angles. These and other circumstances prove that the dykes were produced at different and successive ages. Many of them were fractured and displaced in consequence of movements of the mass of rock traversed by them; and these dislocations are regarded by the author as indicating the vast extent and force of the internal movements, due principally to gravity, which are constantly taking place in the mass of volcanic cones. These movements greatly influence the position of the dykes, and render it difficult to ascertain that which they originally occupied. The dykes thin out at various heights, and their superior and northern terminations were found not to reach the existing surface, notwithstanding the amount of denudation that has taken place; and hence the author concludes that they never reached the surface of Somma, when it was the wall of an active volcano. The author further indicated a process by which beds or plates of lava descending the slopes of a volcano may change their direction, and becoming embedded in the detritus accompanying or following them, may, to a greater or less extent, simulate dykes, although in this case the two sides of the plate will present the differences always seen in the upper and under surfaces of a bed of lava. The orientation-lines of five or six of the observed dykes were said to pass approximately through the axis of the cone of Vesuvius, but all the rest presented great diversities, and some, when prolonged, would not touch the cone at all. In making a lithological examination of the dykes of Somma, the author directed particular attention to the position of the elongated air-bubbles found in the material of each dyke, considering that the direction of the longest axis of these bubbles would indicate the flow of the material when in fusion. He stated that on the whole the long axes of the bubbles are nearly horizontal or pointing at moderate angles upwards in directions very nearly parallel to the plane of the dyke, at the place where they occur. Hence he inferred that the dykes were filled by injection not from below but nearly horizontally. The author further referred to the mineralogical characters of the materials of the dykes, and stated that they are not all composed of leucitic lava; he also mentioned the occurrence of cross columnar structure in some of the larger ones. After referring to the differences observable in the physical condition of the two surfaces of some dykes, the author proceeded to consider the mode of origin of the fissures, which, when filled, constitute volcanic dykes. He maintained that the production of a fissure and its filling with molten matter must have been simultaneous and due to the same cause, namely, the hydrostatic pressure of the liquid lava more or less filling the crater, the pressure originating the fissure into which the pressing liquid at the same time enters; a fissure thus produced and filled will always be widest near the crater, so that if the material of the cone were perfectly uniform the dykes produced will be wedge-shaped. But from the absence of this uniformity and other causes, fissures commenced at the interior and propagated into the mass of volcanic cones can rarely be uniformly distributed round the crater or produced in regular vertical planes in a truly radial direction. Hence the author concluded that it is unsafe to attempt to fix the position of an ancient crater by means of the intersection or concurrence of the lines of apparent orientation of dykes alone. The author stated that the intrusion of volcanic dykes cannot so greatly influence the slope of volcanic mountains as has been supposed.—13. On the metamorphic rocks surrounding the Land's End mass of granite, by S. Allport. In this paper the author described the results of a microscopic examination of certain metamorphic rocks surrounding the Land's End granite, indicating the changes produced by the intrusion of the latter upon clay slate and upon certain igneous rocks. The slates in contact with granite become converted into tourmaline- and mica-schists, and are found to contain crystalline quartz, tourmaline, and three distinct varieties of mica, with occasionally tremalite, magnetite (and andalusite?), and in some localities felspar. Their structure is also changed, the most remarkable changes being foliation with every gradation from nearly straight parallel lines to the most complicated contortions, and concretionary structure by segregation of quartz and mica, the result being a spotted schist. With regard to the origin of the granite of Cornwall, the author said that neither observation in the field nor microscopical study lends any support to the notion that it is a metamorphic rock; but, on the contrary, that there is the

[1] Continued from p. 282.

clearest evidence of former deep-seated volcanic action in the disturbance and alteration described in his paper, and in the enormous number of granitic and felsitic dykes intersecting the country for miles. The mode of occurrence of granite in other localities also seems to him to furnish evidence in the same direction.—14. On the relation of the upper carboniferous strata of Shropshire and Denbighshire to beds usually described as Permian, by D. C. Davies. The author stated his conviction that from the *Spirorbis* limestone upwards to and including the Permian we have one continuous series of deposits.—15. Notes on the physical geography and geology of North Gippsland, Victoria, by A. W. Howitt. The earliest formation of which any trace is left in this district is the silurian, all traces of any older rocks being removed, probably by the same agencies which have contorted and metamorphosed the silurian slates and sandstones. The surface of all these silurian strata show signs of great denudation previous to the deposition of the Devonian. The period that elapsed between these two epochs was one of volcanic activity, apparently sub-aerial and terrestrial, and representing the Lower Devonian. The Middle Devonian strata consist of shales and sandstones devoid of any traces of volcanic action, which, however, again becomes apparent in the Upper Devonian. The latter consists of conglomerates, sandstones, and shales, interstratified with aqueous deposits. The prevailing red colour of these beds the author suggests may possibly indicate lacustrine rather than marine conditions. The next in the series of deposits present in North Gippsland are of Tertiary age, and rest horizontally on the flanks of the mountains at elevations nowhere exceeding 1,000 feet. At the close of the Miocene and at the commencement of the Pliocene periods the land probably was from 300 feet to 400 feet lower than at present. The fact that different genera of fish are found in the streams flowing from the north and south sides of the Australian Alps indicate the high antiquity of that watershed. These mountains have been formed by the gradual elevation of the land *en masse*, and its equally gradual erosion by the streams and rivers.—16. Further notes on the Diamond Fields, &c., of South Africa, by E. J. Dunn. Communicated by Prof. A. C. Ramsay, F.R.S. These notes are intended to serve as additions and corrections to the author's paper read in 1873. 17. On Chesil Beach, Dorsetshire, and Cahore Shingle Beach, co. Wexford, by G. H. Kinahan, M.R.I.A., &c. Communicated by Prof. Ramsay, F.R.S., V.P.G.S. The author carefully compares the situations, structures, &c., of these two shingle beaches, and points out that their wonderful similarity is due to nearly the same natural causes in each case, but that at Chesil the driftage is due to the flow-tide current augmented by waves caused by the prevailing winds, while at Cahore the driftage is solely due to the flow-tide currents, its effects being modified by adverse wind-waves. The sorting of the pebbles on Chesil Beach is probably chiefly caused by the progressive increase in the velocity of the tidal current as it approaches the nodal or hinge-line of the tide in the English Channel. The author considers that the current due to the flow of the tide has greater drifting powers than wind-waves.—18. Some recent sections near Nottingham, by the Rev. A. Irving, B.A. The author describes a section of the strata exposed during the recent construction of a railway line from Carlton, three miles to the east of Nottingham, through Daybrook, to Kimberley.—19. On the permians of the north-east of England and their relations to the under- and overlying formations, by E. Wilson. The author describes the same section as that noticed in the preceding paper.—20. The section at high force, Teesdale, by C. T. Clough.—21. The distribution of flint in the chalk of Yorkshire, by J. R. Mortimer, communicated by W. Whittaker. The author considers that the present shape of the Chalk Wolds of Yorkshire seems to suggest that they are the remains of an atoll or circular reef, probably one of a chain, rather than the fragment of a vast sheet of cretaceous mud deposited in deep water. He thinks that the flint-bearing and non-flint-bearing chalk areas are in the main contemporaneous in Yorkshire. The chalk without flint contains 4·28 per cent. of silica, whilst the chalk with flint contains only 2·12 per cent.—22. On the mode of occurrence and derivation of beds of drifted coal near Corwen, North Wales, by D. Mackintosh.—23. The Cephalopoda-beds of Gloucester, Dorset, and Somerset, by J. Buckman.—24. Evidence of the subsidence of the Island of Guernsey, by R. A. Peacock, C.E. All round the coast of this island, like that of Jersey, are found tree-trunks and other vestiges of old forest-land now submerged. Passages are quoted by the author from various old historians relative to the former existence of this tract as dry land, the submergence of which probably took place in the fifteenth century. The encroachment of the waters is due to the subsidence of the land, and not, as has been suggested, to the breaking in of the sea through some natural barrier upon some already low-lying district. Judging from the old chart of 1406, the amount of depression is equal to 160 feet.

Iowa

Academy of Sciences, June 23.—Prof. C. E. Bessey, president, in the chair. The following papers were read:—A preliminary catalogue of the lichens of Iowa, by C. E. Bessey; also a preliminary catalogue of the orthoptera of Iowa, by Prof. Bessey.—Mounds and mound-builders, by Dr. P. J. Farnesworth, showing by comparisons in anatomical structure and modes of burial, that the present North American Indians are probably a remnant of the same race that built the mounds.—Dr. G. Hinrichs presented diagrams and maps, based on reports from his 100 Iowa weather stations, illustrating the very severe hailstorm in Iowa, April 12, 1876.—Prof. S. Calvin described seven new species of palæozoic fossils found in Iowa; also a probable new species of elephant found in the modified drift, near West Union. Prof. Calvin also gave notice of the occurrence of the Chemung group (N.Y.) in Iowa, and presented a preliminary notice of the occurrence of the marcellus shales in Iowa.—Prof. F. M. Witter presented notes on the land and fresh-water shells near Muscatine, Iowa.—Prof. W. C. Preston gave the "Thermic Wind Rose for Iowa City, based on three years' observations at Laboratory of Iowa State University."—Prof. Bessey read a note on the relations of light and heat to the colours of Iowa wild flowers.—Prof. Hinrichs showed that the waters from the deep-lying rocks of Iowa more nearly resemble the waters of the sea than the surface-waters Prof. Hinrichs also exhibited a photograph of the Amana meteorite collection, made by him, which photograph is to accompany the catalogue he is preparing.

Vienna

Imperial Academy of Sciences, Jan. 13.—The following, among other papers, were read:—Crystallographico-optical researches on some camphor-derivates, by M. von Zepharovich.—On the abdominal tympanal organs of the Cicada and Grilodeæ, by M. von Graber.—A contribution to the physiology of childbed, by M. Kleinwächter. This refers mainly to the quantities of urine, urea, salt, and phosphoric acid secreted after giving birth, and the relation of such secretion to age.—On the changes wrought in epithelium through formation of sarcom, by M. Tauszky.—Some new form-elements in woody substances, by M. Moller. In a cross-section of *Avicennia africana*, *e.g.*, he finds bright concentric circular lines, which the microscope shows to consist of regular parallelo-pipedal stone cells. Spiral thickening he finds in the libriform of *Protea cynaroides*, hort.; so it is not confined exclusively, as Sanio says, to vascular formation. A peculiar arrangement of the parenchymatous elements [illegible] *laria Agallocha*, Reb., is also described.

Jan. 20.—On the heat developed or absorbed in change of volume of bodies, by M. Puschl. For the case of unilateral expansion or contraction of a solid, he gets an expression different from Thomson's formula, and agreeing with Edlund's hitherto unexplained results. He considers the second leading law of the mechanical theory of heat to be in general false, and to be superfluous in the special cases in which it seems confirmed by experience.—On starch-formation in chlorophyll granules, by M. Bohm. *Inter alia*, whatever light intensity suffices for decomposition of carbonic acid, causes also a passage of starch from the stalk into the chlorophyll granules.—Studies on the age of the more recent tertiary formations in Greece, by M. Fuchs.

Jan. 27.—Anatomical and histological notes on *Gibocellum*, a new Arachnid. In outer form it is closely allied to *Cyphophthalmus*, and in internal organisation it furnishes a transition from Phalangidæ to Cheraetidæ.—On the condition of equilibrium of a system of bodies with reference to gravity, by M. Loschmidt. It is shown that in some special systems, in the state of dynamic equilibrium, the mean *vis viva* of the molecules cannot everywhere be the same. Hence Maxwell's law of distribution, according to which this must be the case, cannot forthwith be extended to the case where external forces act on the constituent atoms of the system. The second law of the mechanical theory of heat is not thus invalidated, but certain deductions from it are.

Geological Society, Feb. 15.—The director, M. von Hauer, presented a paper by E. Hussak, of Leipsic, on the eruptive

rocks of Zálasy, near Krzeszowice, which break through sedimentary strata of Triassic age. The author, considering the microscopic structure of these rocks, argues that they are real Trachytes and not Porphyries, as was before supposed. This view is corroborated by the construction of the felspar in regular zones, enveloping one another, the numerous glass-cavities in the latter as well as in quartz, while there exist no fluid-cavities at all, and the abundance of glass and the want of quartz in the seemingly compact base.—Dr. G. A. Koch on the Arlberg tunnel. He showed four sheets of a large and detailed geological map on the scale of 1 : 2000, drawn from nature, representing the nearest environs of the tunnel line on the Arlberg, as it was marked out last summer, and illustrated it by a series of sections and specimen of rock. The whole mass of rock to be perforated by the tunnel belongs to the group of gneiss-phyllite, which just at the Arlberg changes into quartz-phyllite, wherein pure quartz abounds. The tunnel measures 6,470 metres in length, and attains its culmination in 1,423 metres above the sea, running always nearly parallel to the direction of the strata. This tunnel must be led somewhat more than 4·5 kilometres, or about 70 per cent. of its length, through a light-coloured gneiss, which may contain in the least favourable parts about one-fifth of pure quartz. Nevertheless the working of this rock will present no difficulties, as it contains a great deal of felspar, and the vaulting of the tunnel will only be necessary in a few localities where the slates of gneiss are exceptionally very thin. A little more than one kilometre, or about 15 per cent. of the length of the tunnel line passes a nod-slate (Knoten-Schiefer) similar in structure to gneiss, and easily wrought. Scarcely half a kilometre, or about 7 per cent. of the length, belongs to a very hard, small-laminated mica-schist, containing a great deal of quartz, and the rest, somewhat more than half a kilometre, or about 8 per cent. passes a ferruginous mica-schist, including garnets, that abounds more and more in quartz, when coming from Stuben, the Tyrol side of the Arlberg is reached. Dr. Koch also mentioned the difficulties arising from the direction of the strata and the dangerous influence of water in some parts, which are unfavourable to the construction of this tunnel. Finally, he stated that another newly proposed line, though it passes 10·5 kilometres in length directly through the crystalline rocks, would not only afford more security, but also would be less expensive, as the total length of the railroad would be diminished, and the management of it much easier, the culminating point of this longer tunnel lying 108 metres deeper than that of the shorter one.—Dr. R. Hornes gave an account of his last summer's work. In Austrian countries he mapped the valleys of old and new Prax, Hohlenstein, and Sexter, then the eastern declivities of the Ampezzo Valley; in Italy he examined the valleys of Cadore, Auronzo, and Comelico. The detailed geological map presented by him comprises therefore nearly the same region, which Dr. H. Loretz had described in the Journal of the German Geological Society in 1874.—Mr. F. Groger spoke about the occurrence of ores of antimony in the Isle of Borneo.

PARIS

Academy of Sciences, July 24.—Vice-Admiral Paris in the chair.—The following papers were read:—On observation of the infra-red part of the solar spectrum by means of the effects of phosphorescence, by M. Edm. Becquerel. Through two vertical slits in a shutter are admitted two beams of parallel solar rays. One beam, traversing a sulphide of carbon prism and a lens, gives a spectrum which is made to fall on a phosphorescent matter; the second beam passing through a white flint prism gives a spectrum, the ultra-violet part of which is thrown upon the infra-red part of the first spectrum. What occurs is this: In the infra-red part of the one spectrum, the impressionable matter excited by the ultra-violet rays has its phosphorescence destroyed, but unequally, giving an appearance of unequal illumination. Not all phosphorescent substances give the effect immediately, and some do not give it. The best substance was found to be phosphorescent hexagonal blende.—M. Becquerel gives particulars of the lines, wave-lengths, &c.—Note on paraldol, a polymeric modification of aldol, by M. Wurtz.—Second note on the reduction of demonstrations to their most simple and direct form, by M. de Saint-Venant.—Theory of the modification of branches to fulfil different functions, deduced from the constitution of the Amaryllidæ, &c., by M. Trecul. Branches may be divided into the terminated or definite, and the non-terminated or indefinite. The definite branches are the leaves, stipules, spaths, bracts, sepals, petals, stamens, and styles, or stigmatic divisions. The indefinite branches are the roots or subterranean branches and the adventitious, the aerial branches properly so-called, the peduncules, the receptacular cups, the ovaries, and lastly the ovules.—Reply of M. Hira to the critique of M. Ledieu in *Comptes Rendus* of July 10.—On the flowering of *Cedrela sinensis* at the Museum, by M. Decaisne. A Chinese tree.—M. Milne-Edwards referred to the loss sustained by the Academy in the death of M. Ehrenberg, who was one of the Foreign Associates on June 27 last.—On the production of electric effluvia, by M. Boillot. Two modifications of apparatus formerly described.—Photometric researches on coloured flames, by M. Gray. He describes a new method.—Note on the radiometer, by M. Gaiffe. He makes one with the vanes painted dull-blue on one side, dull-red on the other; it will turn either way according to the source of light and heat. Solar rays move it one way, a gas flame or radiation from a heated iron plate sends it the opposite.—On radiometers with vanes formed of different matters, by MM. Alvergniat Bros. No. 1 had vanes of silver and transparent mica; No. 2, aluminium and blackened mica; No. 3, aluminium and unblackened mica; No. 4, a radiometer weighing altogether 600 mgr.; No. 5, silver and aluminium; Nos. 6, 7, 8, mica and varnished copper, green, blue, red, and yellow. Effects are described.—On the cause of movement in the radiometer, by M. Sulet. He supposes it to be a difference of temperature in the faces of the vanes. A radiometer with magnetic needle retained an invariable position of deflection four days, the light source remaining constant. Action of condensed gases cannot be admitted here. Decomposition of alkaline bicarbonates, moist or dry, under the influence of heat and vacuum, by M. Gautier.—Photographic inscription of the indications of Lippmann's electrometer, by M. Marey. The opacity of the mercury column is utilised to obstruct, to a variable extent, a slit through which light passes to the photographic screen. The electrometer is somewhat modified. M. Marey shows the curves got from variation of the electromotive force in the heart of a tortoise and that of a frog.—On the existence of alterations in the peripheric extremities of cutaneous nerves in a case of pemphigoid eruptions, by M. Dejerine.—On the physiological theory of fermentation, and on the origin of zymases (soluble ferments), *apropos* of a note of MM. Pasteur and Joubert on the fermentation of urine, by M. Bechamp.—On the malacologic fauna of the islands St. Paul and Amsterdam, by M. Velain.—On the reproduction of dioic Volvox, by M. Hennegny. Sexuality appears by slow degrees, the male sex before the female, in proportion as the species is exhausted by a sexual reproduction.—On the geological age of some metallic veins, and especially veins of mercury, by M. Virlet d'Aoust.—On the photography of colours, by M. Cros.—On the vertical column observed above the sun on July 12, by M. Gullemin.—M. Larrey presented an Italian memoir by Dr. Minich, "On the antiseptic cure of wounds, and a new mode of dressing." He (Dr. Minich) prefers sulphite of soda to phenic and salicylic acid.

CONTENTS

ERRATUM.—Vol. xiii. p. 155, col. 1, line 15 from bottom, for "mile" read "rule."

THURSDAY, AUGUST 10, 1876

THE MOON

The Moon and the Condition and Configurations of its Surface. By Edmund Neison, F.R.A.S., &c. (London: Longmans, Green, and Co., 1876.)

FROM the earliest ages our satellite has attracted a great portion of the attention of astronomers of all nations, and from its proximity to us it is only right that it should still have a large amount of astronomical labour bestowed on it. This labour is divided into two kinds, that of ascertaining its motions in space, and that of inquiry into its physical constitution. It is of this latter research or the study of selenography, chiefly, that the present work treats. The author tells us that he has taken the "Mond" of Beer and Madler as a basis, but that the greater portion of the material has been mainly derived from eight years constant selenographical observations, principally made with a 6-inch equatorial of fine definition and with a 9½ inch With-Browning reflector. Also, use has been made of some hundred lunar sketches made of late years by different astronomers, and which from time to time have been sent to the author; the work, therefore, is as complete as our present knowledge enables it to be. The first chapter of the book treats of the motions, figures, and dimensions of the moon, and mention is made of the elliptic inequality, discovered by Hipparchus, evection, variation, and annual equation. The alteration in appearance of the lunar surface, due to *libration*, is a matter of the utmost importance in selenography, and the discussion of its effects, together with the formulæ for computing the same at the end of the book, will be useful to those interested in lunar observations. The author then proceeds to discuss the question of a lunar atmosphere, and his arguments in favour of the same, having a surface-density of $\frac{1}{400}$ that of our air, are extremely forcible. It has always seemed strange that the moon should have had neither air nor water, or almost none, and we are glad to see that it is not incompatible with appearances that a mass of air and water should have existed comparable to ours, when the relative mass of the moon and earth are considered.

The weather-beaten and ruined portions of the moon's surface are referred to as indications of the effects of these agents; and in favour of the existence of an atmosphere, Mr. Neison points out that "it may be reasonably supposed that the ratio of the mass of the primitive lunar atmosphere to the mass of the moon would be a similar ratio to that which obtains on the earth, considering the close connection between the two; but such are the conditions prevailing on the surface of the moon, that so far from the resulting atmosphere resembling in surface-density that of the earth, it would only be $\frac{1}{60}$ as dense, for not only is the surface of the moon as compared with its mass much greater, but the force of gravity at its surface is much less powerful, so that from these causes the atmosphere would occupy a much greater comparative volume, and consequently possess a very small density." One would, at first sight, fancy that $\frac{1}{60}$ was too small a probable estimate, but when we consider that the mass of the moon is $\frac{1}{81}$, that of the earth and its surface $\frac{1}{13}$, we get, per unit of area, $\frac{13}{81}$ of the mass of the terrestrial atmosphere.

The force of gravity on the moon's surface being about $\frac{1}{6}$ of that on the surface of the earth, the pressure of the atmosphere at the surface will be about $\frac{1}{37}$ of the pressure of our atmosphere; correcting this for the probable effects of temperature, we get somewhere about $\frac{1}{50}$ as the surface density. The author explains the absence of water and the disappearance of a great portion of the above small quantity of atmosphere by drawing a parallel between the surface of the moon and earth, and stating that "the joint effect of the action of the terrestrial surface oceans and atmosphere has been to form the present crust of the earth, where is to be found locked up an immense mass of water and of the constituents of our atmosphere which originally formed part of the early terrestrial oceans and atmosphere, and by this means probably a very considerable portion of these must have been by now removed. A similar action would have ensued on the moon with this important difference, that as, relatively to these masses the lunar surface is more than six times as great as the earth's, this absorption of the oceans and of the atmosphere would have been not only more rapid, but have been carried to six times the same extent under the same conditions." The present surface density, he therefore argues, may be now $\frac{1}{6}$ of its original state, or about $\frac{1}{400}$ of the density of that of the earth.

The estimated density of Bessel and others from refraction, of about $\frac{1}{1000}$ of that on the earth, is referred to, coupled with a remark that the temperature was assumed by him to be uniform and a factor depending on the difference of the form of gravity at the surface of the earth and moon omitted, and if correction is made for these, the result should be $\frac{1}{60}$ as the surface density. From observation of occultations it has long been known that a difference of some 2″ existed between the semidiameter of the moon as determined by occultations and that determined by direct measurement; irradiation accounts for a part of this, leaving the rest to be accounted for by horizontal refraction, and this, we read, renders a surface density of $\frac{1}{200}$ of that of the earth's atmosphere possible, but from other considerations the author puts the probable density at $\frac{1}{400}$. The effect of such an atmosphere in mitigating the climate is shown, but it is not quite easy to see from the present evidence that such an atmosphere, having a pressure of about one terrestrial ounce to a square inch, will account for lunar appearances, or even if we take the pressure at one time to have been $\frac{1}{37}$ of that on the earth, or six ounces. This will require future observations to settle. We are inclined to think that the author is rather over-zealous in his cause when he states to the effect that the mass of atmosphere over a square mile in area must be estimated in millions of tons. This can scarcely be the case, judging from the above-estimated pressure. The occultations of stars, the blue halo occasionally seen around isolated craters, and Lord Rosse's experiments upon radiation from the surface of the moon are all discussed. The author, however, candidly acknowledges that no definite results can be obtained from them either one way or the other, but is convinced that the balance of evidence is in favour of an atmosphere of considerable magnitude, although of slight

density; and "to neglect this is to render nugatory all attempts to explain the phenomena presented by the moon."

In treating of the physical condition of the lunar surfaces, it is pointed out that Beer and Mädler's frequent quotation, "The moon is indeed no copy of the earth, much less a colony of the same," is not so well founded as it would appear to be; for although the first impression gained from the general appearance of the surface is that it contains neither oceans, seas, nor river systems, with the accompanying formation, but a desert containing innumerable craters and surface irregularities, still on a closer investigation with adequate means, more points of resemblance become manifest. The more level regions of the moon, especially the shores, though known to have been long destitute of water, are pointed out as appearing to show many traces of its action, as the formation of diluvial deposits recognised by Sir John Herschel; whilst Prof. Phillips traced many analogies between the apparent volcanic formations of the earth and moon, and found many indications of the action of a disintegrating atmosphere.

The greater craters apparently existing on the moon when examined with powerful telescopes, the author tells us, appear less and less like volcanic orifices or craters; their inclosing walls lose their regularity of outline and form, and appear as confused masses of mountains broken by valleys, ravines, and depressions, crossed by passes, and surrounded by low plateaus and an irregularly broken surface; whilst the seemingly smooth floors generally appear as diversely interrupted as the environing surface. These formations are thus seen in their true character, not as craters, but as low-lying spaces surrounded by mountain regions or disturbed highlands.

The author appears to think that the *ring plains* and *wall-plains* are not volcanoes, in the ordinary sense of the term, but depressions surrounded by mountain ranges, and that the great number of apparently small craters are mere shallow hollows, such as are not uncommon on the earth.

The fact that gentle slopes and valleys, like many of our river valleys, would not, except under most favourable circumstances, be shown in relief, is a matter which may easily escape notice, and is here referred to; and further, any small abrupt feature may cast a shadow completely masking much more extensive formations. Attention is called to the fact that Mädler pointed out that formations possessing a north or south direction are much more easily seen upon the moon than those extending east and west, a peculiarity tending to give an imperfect idea of the true nature of the surface, and accounting in some measure for the general meridional direction of numbers of the smaller formations of the moon, such as the ridges, land-swells, and rills, as matter very noticeable on a glance at a lunar map.

The variation of the appearance of lunar formations during the course of a lunation is very forcibly described, as also is that due to libration. The effects of the changes in temperature are referred to as causing a physical variation of the surface, and the changes in the crator Linné, and the ring-plains of Messier are referred to as probable instances of physical change.

The various formations on the lunar surface are enumerated and described with considerable minutene With regard to the rills or clefts, Mr. Neison seems incline to the belief that the majority of them are anci river-beds, though at present their nature is purely co jectural.

Some thirty pages are devoted to an abstract of t work done upon the moon by various astronomers fro the earliest times; but we find no mention of Nasmytl and Carpenter's excellent book in this list, a work whi surely deserves some notice.

The book, of 576 pages, is illustrated by five drawin of craters, and possesses no less than twenty-two maŗ containing together the whole of the moon's surface, ea of which is accompanied by a full explanation, taking u at least three-fourths of the book, the scale of the ma being 24 inches to the moon's diameter. Three of tl craters—Gassendi, Maginus, and Theophilus, are draw upon an enlarged scale. This work will, no doubt, be c considerable service to those who make our satellite the chief study, since, besides the objects enumerated b Beer, Madler, and Schmidt, it contains a large amount c new work.

HOVELACQUE ON THE SCIENCE OF LANGUAGE

La Linguistique. By A. Hovelacque. (Paris: Reinwal and Cie., 1876.)

IN speaking lately of the Science of Language w alluded to the question that is still being debate among its students as to whether it ought to be classe with the physical or with the historical sciences. It method is that of the physical sciences, while phono logy, which forms so integral and fundamental a par of comparative philology, is purely physiological in cha racter. On the other hand, since phonetic sounds do not become language until they have been made signi ficant, the science of language may be regarded as a his torical one. M. Hovelacque is a warm supporter of the first opinion, and his book is an attempt to treat the science of language as a physical science pure and simple In this respect he is a follower of Schleicher, as he is also in applying the Darwinian hypothesis to the history of speech and in holding at the same time that the various languages of the world have branched off from a number of independent centres. His work is a valuable contribution to the literature of the subject.

M. Hovelacque starts with the assertion that man is man solely in virtue of language, or rather of the capability of language. Following M. Broca he holds that this capability is a function of the third frontal convolution of the left, more rarely of the right, hemisphere of the brain, and that it was first acquired by a primate which thereby became a man. A certain number of the same primates, "less favoured by circumstances, were checked in their development, and relapsed into a regressive change of character; their remains are to be recognised in the anthropoid apes, gorillas, chimpanzees, orangs, and gibbons." Those primates which by a process of natural selection acquired the capability of speech and with that the characteristics of man, gradually improved upon their new possession, wherever external circumstances were favourable, and with the development

of speech came also the development of conceptual thought and a corresponding progress in culture and civilisation.

A morphologic investigation of language enables us to trace the several stages of its development, and by supplying intermediate forms furnishes an important verification of the Darwinian theory. Thus we begin with isolating languages and monosyllabic roots, and then pass on through the agglutinative to the inflectional family of speech, each family, together with the members of each family, gradually increasing in complexity of organism. The roots themselves can be shown to be of onomatopœic or interjectional origin, and the interval between them and the six distinct sounds emitted by the *cebus azaræ* of Paraguay is far less than that between the several stages of linguistic development. Linguistic development itself depends upon the changes brought about in the pronunciation of words by natural causes, and since the laws which regulate these changes fall ultimately under the province of physiology, the "historical life" of language is as much a subject of natural science as the more special phenomena of the physiologist.

The main objection which offers itself to this theory is the necessity it involves of explaining the development of speech by the accidents of phonetic decay. No doubt the meaning of words is largely influenced by the forms they may assume in pronunciation under the action of phonetic laws which ultimately go back to such controlling conditions as climate, food, and the like; but just as often it is the meaning which determines the form. After all, it is not the particular phonetic sound which constitutes language, but the signification put into it by the joint but unconscious action of a community. Without language, it is true, there can be no thought; but it is equally true that language without thought would be only the gibberish of a parrot.

Another objection which holds against the view of M. Hovelacque is the undue limitation which it imposes upon the science of language. M. Hovelacque's work is little more than a catalogue of the various languages of the world, classified morphologically and genealogically, with a description of the chief phonetic and grammatical peculiarities of each. No place is left for that inner life of language which stands nearer to psychology than to physiology, and the science of language is accordingly made almost synonymous with phonology alone. One misses an account of the nature of language and the causes of its change and growth; one misses equally any reference to comparative grammar and syntax, to the changes of signification undergone by words, and the light they throw upon the history of the human mind. In short, in M. Hovelacque's hands the science of language appears as a classified collection of existing phenomena, while the causes and complex history of these phenomena are left untouched. In assuming, too, that the inflectional languages have once been isolating, M. Hovelacque assumes much more than can be proved. The Indo-European tongues *may* once have resembled Chinese; but there is no proof of the fact, if fact it be, and the "Parent-Aryan," as restored by Schleicher and Fick, is as thoroughly inflectional as Sanskrit itself.

On the other hand, M. Hovelacque does good service in showing how fully all the evidence now at our disposal tells against the theory which would refer the manifold languages of the globe to only two or three original sources. On the contrary it would seem that the beginnings of speech were as numerous as the independent communities of primitive man. It is strange, however, that an author who hesitates about admitting the relationship of the Mongolian to the Finnic-Tatar group should yet accept without questioning the Indo-European affinities of Lycian and Etruscan.

To sum up, M. Hovelacque is a good scholar, and his book is a useful summary of the relationship and characteristics of the various languages of the world. It is also a valuable contribution on the side of those who hold that the science of language must be included among the physical sciences. But it exhibits the defects as well as the advantages of this view; and thus while it proves the difficulty of distinguishing between a physical and a historical science at least so far as the science of language is concerned, it yet shows that to regard the science of language as a merely physical one leads to an unsatisfactory inadequacy of treatment and an unjustifiable narrowness of view.

A. H. SAYCE

THE GERMAN NORTH SEA COMMISSION

Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel fur die Jahre 1872, 1873. Im Auftrage des Königlich Preussischen Ministeriums fur die landwirthschaftlichen Angelegenheiten, herausgegeben von Dr. H. A. Meyer, Dr. K. Möbius, Dr. G. Karsten, Dr. V. Hensen, Dr. C. Kupffer. (Berlin, 1875.)

THE second portion of the Report of the North Sea Expedition, just published, contains Article VI., Bryozoa, edited by Dr. Kirchenpauer. Like most of his countrymen, the author accepts Ehrenberg's name for this group, although there is no doubt that, as urged by Allman and Busk, Vaughan Thomson's name (Polyzoa) has the priority. The number of species met with is but small; we make it 55, the author 54, but perhaps he excludes *Pedicellina echinata*. A most interesting account is given of the Flustra of the Northern Sea, and we welcome the account of the geographical distribution which is appended to each species as a valuable addition to our knowledge. From the richness of Dr. Kirchenpauer's collections, he was peculiarly well able to give a long list of habitats. Among the very complete list of authors quoted, we miss a paper on New Zealand Polyzoa by Sir C. Wyville Thomson, published in the Natural History Review for 1858.

The Tunicata are described by Dr. C. Kupffer. Twenty-four species (not twenty-three) of Simple Ascidians are enumerated, belonging to the following genera:—Ciona, 3 sp.; Phallusia, 6 sp.; Corella, 1 sp.; Cynthia, 8 sp. (1 new); Molgula, 5 sp. (3 new); Pelonæa, 1 sp. The author describes as occurring in some species of Cynthia and Pelonæa certain nipple-shaped bodies met with in the water chamber. These are regarded as standing in close relationship with the circulatory system, and are called Endocarps. All of the species, except those for the first time described, are to be met with in Great Britain; some of them are among those recently described by Alder and Hancock from the West of Ireland, and five of them are

represented in a coloured plate. Of the Mollusca, the Gymnobranchs are described by Dr H A Meyer The number of species met with is but twenty three, there is not much that is noteworthy in the list, but that "singular and gaudy animal" of Montagu, *Il u r p um r r*, o r ure on the British coasts, was met with The list of the Brachiopods, Lamellibranchs, and Gasteropods is a very elaborate one, drawn up quite after the fashion of our British Association Dredging Reports, the locality, depth in fathoms, and nature of the ground in which each species was found is given and a sketch of its geographical distribution is added The greatest depth reached was about 365 fathoms *C r r r m n l r* and *L r l r l u lina caput s r f nts* appear to have been met with in quite shallow water *M ll tr l ld a ol usr*, Sm , *A ll lr ab uola* Sars and other deep sea species were in water at depths of from 50 to 365 fathoms The following species are described as new *l r unr s l r*, of Yarmouth, *I a oro hlr f mn r r r* nov gen et sp *l r r merlu*, and *Latl r u ll lr* These three latter species are figured

Article IX, by Dr Möbius, describes the Copepoda and Cladocera *Fu h l r tl*, sp n, is described and figured The remaining ones of Crustacea are described by Metzger We note the appearance in the North Sea of an Ichthyophthirius form, thus indicating the presence of a Squilla *Gilla r lndi r*, Kin is placed as a synonym of *G m n l r*, Lilljb *lll r , lu A r edulis, Lithocus n fl n sh* and other interesting forms, were met with *Sc l s M r r, lj l r r co us* and *Dult lam r anl* are described and figured as new

The list of fish taken is most meagre, containing but thirty two species

The meteorological investigations of Prof Karsten are exceedingly interesting and records are appended as to the temperatures of the sea at various depth

Dr Hensen appends a Report on the Fisheries of the German Coast, in which we find elaborate statistics of the number of fishing stations, of the fishermen, and the amount of assistance given to them The off shore fishermen are distinguished from the deep sea trawlers The number of fishermen on the German coasts is 17,495, with say 8,130 boats, the number of English fishermen, is given as 134,000, with 36 000 boats In France the number is 73,757 men, with 16,819 boats, in Italy, 60 000 men and 18,000 boats, in Austria, 7,196 men and 1,852 boats These numbers are based on reports dating between 1871 and 1874

A portion of the Report is devoted to the subject of the possibility of estimating the take of fish According to the official return of the German Treasury on the import and export of fish during 1873, it would appear that these equalled on—

		m
River fish and cray fish		342 000
Sea fish in general		3,150,000
Herrings	·	27,798 000
Shell fish	...	387,000
Caviar		973,000
Total		32,650,000

This portion of the Report of the North Sea Commission ought to be studied by all those interested in our own [illegible]

E. P. W.

OUR BOOK SHELF

Eighth Annual Report of the Noxious, Beneficial, and other Insects of the State of Missouri By Charles V Riley, State Entomologist

THE perusal of Mr Riley's yearly report, is one of the pleasures to which the entomologist looks forward with undiminishing eagerness Each succeeding volume throws open to the student of science fresh fields of discovery in the realms of both natural ... Mr Riley's ready appreciation of a practically useful invention, accompanied by that quick discernment which enables him at once to reject or ... tify what is useless or cumbersome, renders him especially fitted for the responsible position which he occupies

The report now before us is devoted to the consideration of five noxious insects, and one innoxious—the Colorado Beetle, the Canker worm, the Army worm, the Rocky Mountain Locust, the Grape Phylloxera, and the Yucca borer, the larger space being given to the third and fourth of the above mentioned pests, in consequence of the ravages which they have committed in Missouri during the past year

In the chapter on the Canker worm an illustrated description is given of a very simple and ingenious contrivance (p 20) for arresting the progress of the insect at the time of oviposition It consists of a ring of tin which surrounds the trunk of the tree at a few inches distance, and which is held in position by a circle of ... of tin ... fastened closely round the trunk with a cord, the top then stuffed with ... and kerosene on its inner surface, which forms an effectual barrier to the ...

Other interesting inventions are described and not only are the ... of the ... so ... that it is the agriculturist's own fault if he fails to distinguish between his friends and foes

The report concludes with the life history of the Yucca borer (*... ... ...*) ... hitherto referred to the moths, but which Mr Riley ... to be ... Judging by the figure of the adult insect one might be questioned whether this insect is not more nearly related to the ... this, it has the ... of a ... with the wrinkled and (apparently) hairy character and general coloration of a ... , ... but ... out the resemblance, the rapidity of its flight ... with what is notoriously the character of a Hawk moth and the form of its antennæ ... such an affinity still it must in fairness be admitted that Mr Riley adduces much evidence in favour of the Rhopalocerous character of the species, the value of which cannot be contradicted until we can bring forward proof that some undoubted moth possesses the same structural peculiarities

A G B

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts No notice is taken of anonymous communications*]

Optical Experiments

I roll a sheet of writing paper into a tube whose diameter is about 3 cm Keeping both the eyes open, look through[2] the tube with one eye, and look at the hand with the other, the hand being placed close by the tube An extraordinary phenomenon will be observed A hole the size of the tube will appear cut through the hand, through which objects are distinctly visible That part of the tube between the eye and hand will appear

[1] Mr Riley notes it resembles ... (p 177)

[2] It is necessary to focus the eye upon any object seen *through* the tube —Ed

transparent, as though the hand were seen through it. This experiment is not new, but I have never seen it described. The explanation of it is quite evident.

2. Drop a blot of ink upon the palm of the hand, at the point where the hole appears to be, and again observe as before. Unless the attention be strongly concentrated upon objects seen through the tube, the ink-spot will be visible within the tube (apparently), but that part of the hand upon which it rests will be invisible, unless special attention be directed to the hand. Ordinarily the spot will appear opaque. By directing the tube upon brilliantly illuminated objects, it will, however, appear transparent, and may be made to disappear by proper effort. By concentrating the attention upon the hand, it may also be seen within the tube (especially if strongly illuminated), that part immediately surrounding the ink-spot appearing first.

3. Substitute for the hand a sheet of unruled paper, and for the ink-spot a small hole cut through the paper. The small hole will appear within the tube, distinguishing itself by its higher illumination, the paper immediately surrounding it being invisible. Many other curious experiments will suggest themselves. For example: if an ink-spot somewhat larger than the tube be observed, the lower end of the tube will appear to be blackened on the inside.

4. While making these experiments, an improvement upon the experiment described in NATURE, vol. xii., p. 502, was suggested, as follows:—Look through a paper tube with one eye at green paper, and through another tube with the other eye, at red paper. The paper should be illuminated by the direct solar ray. The two colours, at first vivid, are rapidly enfeebled. After half a minute, transfer both eyes to either one of the papers, say red. To the eye fatigued by green, the red colour is very brilliant, and the effect is the more striking on account of the simultaneous impressions now received by the two eyes.

Washington University, St. Louis

F. E. NIPHER

Antedated Books

THE evil practice of issuing antedated periodicals has long been a matter of complaint amongst naturalists. The editor of the *Journal fur Ornithologie* is a well-known sinner in this respect the quarterly number of that journal, although invariably dated on the first day of each quarter, being always several months in arrear. But a still more flagrant instance of this practice is now before me in the third number of the new edition of Layard's "Birds of South Africa," which, although only issued to the subscribers within these last few days, is dated on the cover "May, 1875!" As two new genera (*Aethocichla* and *Neocichla*) are instituted herein, the result is to give these names an unjust priority of fifteen months over what they are legally entitled to. This seems to be a still easier method of gaining precedence than the American practice of publishing telegraphic bulletins of new discoveries, and will not, I trust, be persevered in, if attention is called to it.

F.Z.S.

August 7

Protective Mimicry

I HAVE been reading over in the file of NATURE the controversy that arose out of Mr. Alfred Bennett's paper at the British Association in 1870, on "Natural Selection from a Mathematical Point of View," in which he attacked Darwin's theory on what seems to be one of its strongest points, namely, protective mimicry. I do not feel certain whether he is right or not in denying that natural selection is adequate to produce mimicry. The argument really depends on a question of fact, namely, whether the first variation could be great enough to be useful to its possessor; and from the great comparative variability of colour, I see no decided impossibility in this.

But the writers in that controversy neglected other facts of colour which it seems impossible for natural selection to produce, from the infinite improbability of a first variation ever occurring. One of these is the change of colour with the seasons in such animals as the ermine, which is brown in summer and white in winter. Had the ermine been either permanently brown or permanently white, there would have been nothing wonderful in it, but it seems impossible that the character of becoming white in the winter and brown in the summer could ever have originated in ordinary spontaneous variation, without a guiding intelligence.

Another case of at least equal difficulty is the case of change of colour for the purpose of protection, from moment to moment. The chameleon is the best known instance of this, but I believe there are many such cases among fishes. It seems utterly impossible for such a character to originate in spontaneous unguided variation.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, July 20

A REMARKABLE instance of this phenomenon is shown in a small crustacean, of the genus "Rypton" (Mr. Spence Bate has not yet determined whether it be a new species or not). This very delicate little animal is found only in holes in the coral inhabited by the common "Echinus" of Mauritius; its colour is a deep purple, with four longitudinal stripes of a much lighter tint; and this is precisely the pattern of the spines of the said Echinus.

WILMOT H. T. POWER

λ Ophiuchi

I AM going to undertake the calculation of elements of λ Ophiuchi, which you proposed to calculators in NATURE, vol. xiv. p. 29. I shall also within a short time give orbits of γ Coronæ, which has not been separated as far as I know since spring, 1867, when it was observed in Harvard College, and of ξ Libræ (Scorpii). About the latter binary star we know but very little. Madler has given a circular orbit with a period of over 100 years, while Thiele gives a highly eccentric orbit with a period of about fifty years. It may very likely be found that the older determination is the most trustworthy, but the case deserves a thorough examination, which I am going to make. I have been engaged in a re-determination of elements of σ Coronæ, by which the long period has been re-ascertained.

There are different other double stars which with advantage might be inquired into, and thus prevent different investigators from confining themselves to the same objects, while others remain uncared for. I hope that you will be kind enough to publish the above remarks in your widely circulated paper.

Markree Observatory, Collooney, Ireland, July 17

WILLIAM DOBERCK

The Cuckoo

THE cuckoo is still singing in this part of the country. I may mention, as a point of some interest, that the note of this bird in South Germany is precisely the same in pitch as it is here, the observations in both cases having been made with a tuning-fork in the month of May.

Can any of your readers inform me whether the cuckoo *in all parts of the country* is in the habit of occasionally singing the *cuc* without the *koo*?

GEORGE J. ROMANES

Ross-shire, July 24

THE FERMENTATION OF URINE AND THE GERM THEORY

CAN Bacteria or their germs live in liquor potassæ (Pharm. Brit.) when it is raised to the boiling-point (212° F.)? Such is now the simple issue to which certain great controversies have been reduced. If Bacteria germs cannot resist such an exposure, then, by M. Pasteur's own implicit admission, his exclusive germ-theory of fermentation must be considered to be overthrown by the broader physico-chemical theory. The truth or not of M. Pasteur's germ-theory is the central question in dispute, but standing on either side, or in close juxtaposition, are two dependent subjects of controversy whose importance for biological science and for medicine is even greater.

The question whether living matter can or cannot originate *de novo*, for example, depends upon the answer which is to be given to the question whether Bacteria and their germs are or are not killed in boiling liquor potassæ. This, also, is practically admitted by M. Pasteur in his comments (*Comptes Rendus*, July 17) upon my recent experimental evidence.

The other subordinate problem, the solution of which

depends upon the same issue, is the truth or falsity of an exclusive germ-theory in explanation of the origin and spread of the communicable diseases. If the germ-theory of fertilisation can be proved to be untrue, and if living ferments can be proved to originate spontaneously, we should soon cease to hear much about an exclusive germ-theory of disease. This derivative doctrine would not long survive the death of its parents.

Thus M. Pasteur's theory of fermentation, the popular doctrine *omne vivum ex vivo*, and the germ-theory of disease, must all be simultaneously overthrown if it cannot be proved by M. Pasteur, or some of his followers, that Bacteria germs are not killed when they are immersed in strong liquor potassæ raised to 212° F. (100° C.). How matters have been brought to this desperate predicament may be explained in a very few words.

Since the year 1862, M. Pasteur has defended four main positions, on the strength of which he has based his germ-theory of fermentation, his repudiation of "spontaneous generation," and his support to the germ-theory of disease. In the year 1870 and subsequently, I have many times submitted these four positions to an independent criticism by means of experiment, and the result has been a confirmation of two of them, and a rejection of the remaining two—the rejection being necessitated rather on account of facts obtained by new methods than from any implied defect in the particular range of experiments from which so distinguished an investigator as M. Pasteur deduced his opinions. Our respective views on these four points may be thus tabulated:—

PASTEUR	BASTIAN
1. That *all* boiled organic infusions having an acid reaction will, when protected from contamination, invariably remain pure.	1. That *some* boiled organic infusions having an acid reaction will, when protected from contamination, ferment and swarm with Bacteria.
2. That all Bacteria and their germs are killed in such boiled acid fluids.	2 Do.
3. That *some* boiled organic infusions having a neutral, or slightly alkaline reaction, will not remain pure even when protected from contamination. They will, on the contrary, ferment and swarm with Bacteria.	3. Do.
4. That all Bacteria and their germs are not killed in such neutral or slightly alkaline fluids raised to 212° F. (100 C.).	4. That all Bacteria and their germs are killed in such neutral or slightly alkaline fluids raised to 212° F. (100° C.).

Omitting, for the present, all intermediate stages of the controversy which has now been carried on for several years between one or other of M. Pasteur's followers and myself, I will proceed to show how the questions between us have been affected by my latest researches.

The results obtained in these researches have been embodied in a memoir communicated to the Royal Society on June 15, of which an abstract was published in NATURE, vol. xiii., p. 220. A very short "Note" on the subject of these researches was also submitted to the *Académie des Sciences* on July 10, and subsequently published in the number of the *Comptes Rendus* bearing that date. M. Pasteur replied to this note at the next meeting of the Academy (*Comptes Rendus*, July 17), at a time when he would appear not to have seen the fuller abstract of my researches published in NATURE. This will account for an error into which he seems to have fallen in regard to one of the most important conditions prescribed for some of my experiments, to which I shall have occasion presently to refer. In the first place, however, I must call attention to a different part of the subject.

One of the most notable results of my recent work is this:—I have ascertained that a moderately acid urine will, after it has been boiled, remain pure when kept free from contamination at a temperature of 77°–86° F. (25°–30° C.), though the same specimen of "sterilised" urine will ferment and swarm with Bacteria in less than three days, if it is maintained at the higher temperature of 122° F. (50° C). Many acid vegetal infusions will behave in precisely the same manner.

Here, then, is a ready means by which any careful experimenter may ascertain whether M. Pasteur is not wrong in maintaining his proposition No. 1. And if this is the case, then there is nothing for M. Pasteur to do but to renounce his exclusive germ-theory of fermentation, and to adopt the doctrine of "spontaneous generation," since he still declares that Bacteria and their germs are killed in acid fluids raised to 212° F. (100° C.). His words are (*Comptes Rendus*, July 17, p. 179):—"J'ai prouvé directement qu'ils perissent dans un milieu acide à 100 degrés."

But there is another means of establishing the truth of my conclusions derived from these recent researches to which I will now allude. This is the point principally referred to in my "Note" to the Academy, and upon which M. Pasteur dwells in the above-mentioned communication.

As regards the frequent fertility of boiled organic fluids having a neutral or faintly alkaline reaction (No. 3) it will be seen that M. Pasteur and myself are thoroughly agreed, notwithstanding Prof. Tyndall's representations to the contrary, made in the columns of this journal in the early part of this year. M. Pasteur now says (*Comptes Rendus*, July 17, p. 178):—"Je m'empresse de déclarer que les expériences de M. le Dr. Bastian sont, en effet, très exactes; elles donnent *le plus souvent* les résultats qu'il indique . . . Il n'y a donc entre M. Bastian et moi qu'une différence dans l'interprétation d'expériences qui nous sont maintenant communes." The difference of interpretation to which M. Pasteur alludes depends upon our difference of view in regard to position No. 4. It was specially with the hope of dissipating any doubt remaining upon this part of the question that one section of my new experiments was undertaken. I determined to submit M. Pasteur's interpretation to the test of direct experiments, conducted in a way likely to yield decisive results.

If the fertility of the boiled neutralised fluids or infusions were really due to the survival of germs, as M. Pasteur supposes, then the boiling of the fluid in its acid state (when its germs would by admission be destroyed), and the subsequent addition to it of a sufficient amount of boiled liquor potassæ, without extraneous contamination, should be attended by negative results—that is, the fluid should remain pure, according to M. Pasteur, if it were really germless.

But numerous experiments performed in this manner have shown me that sterilised urine, to which boiled liquor potassæ, in proper quantity, is added, will ferment and swarm with Bacteria in a few days and all the more quickly if the experimental vessels and their fluids are maintained at a temperature of 122° F. (50° C.).

M. Pasteur, whilst admitting the facts, says that this addition of boiled liquor potassæ to sterilised urine causes the mixture to ferment because such added liquor potassæ contains germs which were not killed when this fluid was raised to 212° F. (100° C.).

This, truly, is an astounding hypothesis. My reply, however, is simple. It was an objection already anticipated and met by me, as any one may see by referring to the concluding portion of my abstract, as published in NATURE.

The answer is this:—If boiled liquor potassæ were a germ-containing medium, then one or two drops of it (as of other germ-containing media) would always be capable of contaminating many ounces, or even a gallon or more of sterilised acid urine. This, however, is never the case.

THE MUSEUM OF NATIONAL ANTIQUITIES OF FRANCE

ALL the French national museums are located in Paris with the exception of the Museum of National Antiquities, which is at some distance from Paris, in a small town of the *banlieue*. Although the Château de Saint Germain, which has been allotted to that interesting and really national collection, is a very picturesque monument, and the forest round a favourite pleasure ground for Parisian families, the site allotted to the museum about ten years ago was not selected with the view of giving an additional attraction to the place. But the very idea of collecting relics of prehistoric ages in order to demonstrate that our ancestors lived in the age of the so-called diluvian animals was opposed by a formidable number of influential people.

Napoleon III., personally a believer in the new theory, insisted upon the creation of the museum, but he assented to place it at St. Germain in order not to offend directly the prejudices of a formidable number of his supporters.

The St. Germain château was elegantly built in brickwork by Francis I., the king chevalier, who dedicated it to his fair dame, Diane de Poitiers. It was within its walls that Louis XIV. was born, and the government of the Mazarin was sitting in its elegant precincts when Paris was in the hands of the Fronde. Louis XIV. disregarded the building where his cradle had been surrounded by such dangers, and built Versailles with all its magnificence at a small distance of six miles. So St. Germain sank gradually from the dignity of a regal residence into the degrading condition of a prison for soldiers condemned to penal servitude by the Council of War of the First Military Division. The site was only famous as being the favourite spot where Alexander Dumas built his celebrated villa of Monte Christo, and the first place connected by a railway with Paris, as early as 1837.

The opening of the museum was the inauguration of a new era for the castle of St. Germain. Reparations and restorations were begun with activity, and are proceeding with such zeal that in the course of two years hence they will be completed. During the Franco-German war St. Germain was a stronghold of the German armies besieging Paris, but the museum remained unmolested, having been taken by the Emperor William under his special protection, and M. Gabriel de Mortillet, the *conservateur*, who had remained at his post, took advantage of his influence to protect the inhabitants of the city with much energy.

His superior, the then Director of the Museum, is M. Alexandre Bertrand, a brother to M. Joseph Bertrand, the present Perpetual Secretary of the Academy of Sciences. The museum is now placed under the control of the historical commission for constructing the Map of Gaul. This learned body is publishing a magnificent series of maps and engravings in order to illustrate the progress of the science of the prehistoric period, as well as of the Gallic, Roman, Gallo-Roman, and Merovingian. They are also manufacturing in the establishment models of the objects exhibited which cannot be sold for money, but are sent by the Government to the several provincial museums, or presented to learned men in consideration of objects given to the museum, so that they may be acquired by way of exchange. There is also in the establishment a special library in which have been collected by M. Gabriel de Mortillet all the books relating to prehistoric antiquities, and which is open free on certain days to the public. A carefully compiled catalogue has been prepared, and is to be published.

The establishment is in some respects connected with the Prehistoric Congress, M. Gabriel de Mortillet having originated the idea at La Spezzia, and M. Alexandre Bertrand or he having been delegated by the Government to all similar meetings which have taken place since that period. M. Alexandre Bertrand was delegated to Stockholm last year.

The objects collected in the galleries are very numerous, arranged in excellent order, and accompanied by inscriptions sufficient for the perfect understanding of their historical bearings. A catalogue has been issued, and is sold at a small price by the porters.

In the basement have been located casts from the Trojan column for showing the arms and manner of the Romans when practising warfare.

In the same part of the building are to be found the models of Roman arms which were tried in the Polygon of the forest before the members of the Congress of Geography, as mentioned in our "Notes."

These apparatus were constructed by a French officer in order to elucidate questions raised by the publication of "La Vie de César," edited by Napoleon III., who had secured the collaboration of a number of eminent members of the Académie des Sciences Morales et Politiques. Two volumes of that altogether interesting and well-written book (although the theories of Cæsarism cannot be said to have borne the severe test of facts) have been published by M. Plon, the editor of his Imperial Majesty. The first sold immensely, as Napoleon III. was then at the zenith of his power, but the circulation of the second, issued a few months before the Franco-German war broke out, was very limited indeed; so limited that the editor prosecuted the Emperor to recover the money spent by him, but the petition was discharged with costs.

It is for the publication of "La Vie de César" that the siege of Alesia, the crossing of the Rhine, &c., have been expeditiously and carefully executed. The building of bridges over powerful streams, encampments established, assaults given, cities defended, all the warlike operations of the Romans can be understood by a visit paid to the Museum of St. Germain. All this would have remained a mystery for thousands of visitors, as the museum is fast becoming a place of resort, if Napoleon III. had not felt it necessary to justify by historical arguments his theories on the advantages of the government of societies by men with a special destiny.

The large hall in the second floor may be said to be the most essential part of the museum. It contains the famous Moulin Guignon jaw and other human fossils discovered by Boucher de Perthes. In a glass case have been exposed seriatim the celebrated bones embellished by prehistoric artists with sculptures of the then living animals.

A magnificent bust of Boucher de Perthes, and another of Christy, the famous English banker and amateur geologist, have been erected side by side in a conspicuous place. It is a justice paid to their joint labours in the foundation of prehistoric science. It was due to the moral courage displayed when resisting the authorities, of such men as Cuvier, Elie de Beaumont, Buckland, and a number of other official geologists, and to the ingenuity displayed in the demonstration of such important facts.

On the walls have been painted magnificent maps exhibiting the distribution of caves and places where stone or bronze implements have been discovered, and the limits of the several Gallic tribes in existence when Cæsar invaded Gaul. A number of pictures *al fresco* are exhibited showing the several phases of prehistoric life, principally in lake-dwellings.

No such institution is to be found in England, although cave-hunting is becoming an important pursuit in the country of Lubbock, Lyell, Huxley, and Dawkins. A visit to St. Germain is a very useful way of spending a holiday, especially if the visitor has previously written a note to M. Gabriel de Mortillet, who is always ready to give kindly personal explanation to foreign visitors.

W. DE FONVIELLE

THE BASKING SHARK

To many it may be a quite new and strange fact that the Basking Shark, almost the largest fish now living, is to be commonly met with at certain seasons around the western part of the British Islands. The fine specimens recently added to the zoological collections of the British Museum and the Royal Dublin Society have excited some wonder; but the popular mind, while it associates sharks with tropical seas and coral reefs, seems as yet hardly to have taken in the fact that if it wants to see about the biggest of all sharks in small shoals, playfully gambolling, it need wander no farther than to the Atlantic coast of Ireland. There, towards the end of April, and often all through May, these Basking Sharks will be met with. They have even been counted off Tory Island in shoals of from sixty to a hundred, basking in the bright morning suns of June.

It is about 110 years ago since the esteemed Bishop Gunnerus (born 1718, died 1773) published an account of this big fish in the Trondhjem Society's Journal, and a great number of authors have written on the subject since then. Under many local names—Basking Shark, Sun fish, Pelerin—it has been well known to fishermen; it reaches a length of 40 feet, although average sized specimens do not measure more than between 20 and 30 feet in length; of large size, and shark though it be, it would appear, like many other big animals, to be of a gentle, mild, and placid disposition, to be fond of sunning itself on bright days, and to never interfere with mankind unless when they interfere with it; and yet with all these facts in its favour, the animal being, so to speak, common, having local names, being of a size not easily overlooked, and not being, like its cousin the Blue Shark, a man eating devil, this *Selache maximus* was very little heard of and less known until the other day. Twelve months ago Dumeril, in his "Ichthyologie Générale," could with truth write about the specimen in the Museum at Paris: "Il semble être, jusqu'à présent, le seul représentant dans les Musées de l'Europe centrale de cette énorme espèce des Mers du Nord." To this moment nothing very exact is known as to its food. Pennant thought it fed on marine plants, Linnæus considered its food to be medusæ; some fishermen foolishly think it lives on herrings; and as to its times and seasons nothing is known. Why does it come from north to south, and why then go north again?

So little being known about its form and habits, it is not much to be wondered at that very little is known about its anatomy; and yet Sir Everard Home wrote an anatomical account of it, which is to be found in the *Philosophical Transactions* for 1809, in which he tells us that he found in the stomach of this fish structures showing a link in the gradation of animals between the whale tribe and the cartilaginous fishes. Why, to work out this idea alone ought to send the comparative anatomists off at once to Tory Island or Bofin.[1] We would, however, refer to another anatomical peculiarity, which, had it been known to Sir E. Home, would doubtless have clenched his argument, namely, the presence of rays or fringes of a whalebone like substance along the gill openings. It is true that Gunnerus in 1766 refers to these strange fringes; it is true that in the museum of that far north city of Trondhjem—and within view of the wondrous old cathedral where Gunnerus lies buried, and where to this day Norway's kings are crowned—there is to be seen a piece of one of them; that other Northern Museums, those of Christiania, Kiel, and Copenhagen also possess pieces, and equally true, that during all these days Gunnerus's statements had been overlooked, and these fringes were a puzzle to everyone who examined them. Prof. Hannover, indeed, in 1867, from their minute structure, described them, and thought they were planted on the outside of the fish's skin, like the long spines of certain rays.

Prof. Steenstrup, in whose charge the specimen we figure is, and to whose kindness we are indebted for the figure (1), having made up his mind that it did belong to the Basking Shark, proceeded to work out its history, and so came upon Gunnerus's description, which enabled him

Fig. 1

to suggest that this shark must have the interior of its mouth furnished with branchial fringes of a peculiar nature. He further argued that these must act as strainers; that the shark takes in whole volumes of minute food, catches it on these fringes, and then swallows it. He declares it to be a great mistake to call this fish a carnivore, that is, if he eats flesh at all, it is small flesh, not big flesh. He then objects to the writer of these lines, when describing a shark found in the Seychelles—"which is, the north whale excepted, the largest of living animals"—saying, "contrary to the habits of sharks, this one is not a carnivorous, but a herbivorous fish," as being too much on the other extreme. My excellent friend is right, and I have now no doubt that both these big, lubberly beasts which in their mouth have scarcely more than the name of teeth—feed on all sorts of minute oceanic creatures, frequently taking in with them floating algæ. And he will be glad to know that, acting on the hint in his paper, when Mr. Cullen, the assistant in the Trinity College Dublin Museum, went down to Bofin in May of last year to preserve for

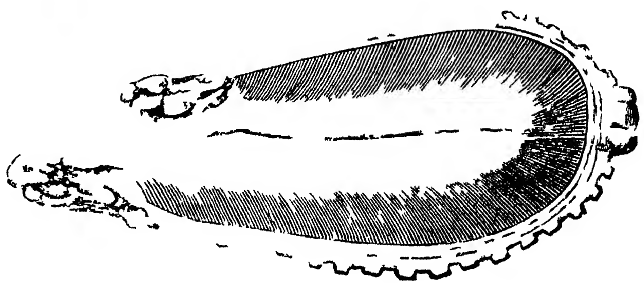


Fig. 2

Dr. Carte the specimen now in the Dublin Museum, the first thing he did was to put his hand into the still quite fresh branchial openings, when he at once felt what Gunnerus had felt in 1766, the whalebone like fringes. It is to be hoped that my colleague, Prof. Macalister, will ere long give an account of this specimen; in the meanwhile a description of the annexed (Fig. 2) drawing of these fringes—now for the first time figured *in situ*—will not be without some interest.

The gill openings are five in number on each side of the neck. The first pair almost meeting on the top of the back. A thought here strikes us. As a rule these gill

[1] Islands off the west coast of Ireland—well known localities for this shark.

lits in the large sharks are small, here they are of immense size. Their function is to allow of sufficient water to flow in and over the gills to oxygenate the fish's blood; but in Selache they serve also as supports to the strainers, and as so big a body must require a great lot of food, the in-takings and out puttings must be many, and might account for the gradual increase in the size of these slits until they reached their present immense proportions, where they have to subserve both the functions of nutrition and circulation. The convexity of the gill openings is towards the shark's mouth, the concavity of these fringed rays is in the same direction. The edge represented in the drawing as jagged—an appearance assumed in drying—is attached to the inner edge of the flaps covering the gill-openings, being somewhat more firmly attached towards the central portion, which in the drawing is far too cartilaginous looking. The gills are outside the whalebone fringes. There seems little reason to doubt but that the free points of the fringes of the one row can be so erected from its gill ray edge as to bend forwards and join, and perhaps slightly interlace with those of the opposite row, and thus there would be a series of arches of whalebone protruding into the neck cavity of the fish. When these fringes are applied to the surface of the gill rays, the water could flow without resistance. The gills were quite free from parasites, in this respect differing from the gills of the Rhinodon of the Seychelles. Although this is not the place to enter into minute details, there is little doubt that Dr. Fleming is wrong in stating that the skin seems smooth when the hand is passed from the head to the tail, and yet though the scales are, as described by Dr. J. E. Gray, armed with small curved points bent in all directions, so that the skin feels rough each way, the hand can be rubbed several times more easily from head to tail than from tail to head, indicating that a larger number of the curved points are directed towards the tail.

The oil from the liver of a medium sized Basking Shark is worth nearly 40*l.* sterling, but the difficulties and danger of capturing these sharks seem altogether to be greater than those attending the whale fishery. The same was true at the Seychelles. Men engaged at the sperm whale fishery off St. Denis often told me they dreaded to harpoon by mistake a Rhinodon. A whale must come up to breathe or else choke itself. But there were stories told me of how a harpooned Rhinodon, having by a lightning like dive exhausted the supply of rope, which had been accidentally fastened to the boat, dived deeper still, and so pulled pirogue and crew to the bottom—there, in spite of the harpoon in its neck and its attendant incumbrances, it was at home for a great length of time.

ED. PERCEVAL WRIGHT

ON THE PHYSICAL EXPLANATION OF THE INEQUALITY OF THE TWO SEMI-DIURNAL OSCILLATIONS OF BAROMETRIC PRESSURE[1]

THERE are, perhaps, few phenomena in the domain of terrestrial physics which have received more attention than the diurnal variation of barometric pressure, and on the causes and explanation of which, nevertheless, there is more diversity of opinion even at the present day. Dove, Sabine, Herschel, Espy, Lamont, Kreil, Broun, and many others have in turn engaged in the discussion of this vexed problem, and at the present time Mr. Alexander Buchan is publishing an elaborate and most valuable *résumé* of the existing data in the *Transactions* of the Royal Society of Edinburgh as a preliminary to a renewed investigation.

The general features of the diurnal variation of pressure are familiar enough to every one who has ever observed the rise and fall of the barometer for a few days in India, and most other tropical countries. From about 3 or 4 in the morning the pressure increases gradually towards sunrise, then more rapidly, and culminates generally between 9 and 10 A.M. A fall then sets in, which becomes rapid during the hottest hours of the day, and the pressure reaches its minimum generally between 4 and 5 P.M. The pressure then increases till about 10 P.M., but in general does not attain the same height as at the corresponding morning hour. Lastly, a second fall brings it to a second minimum between 3 and 4 A.M., which, except on mountain peaks and at such stations as Simla and Darjiling, is, as far as my own experience goes, never so low as the afternoon minimum.[1]

Thus, then, the pressure rises and falls twice in the twenty four hours, attaining, in general, its absolute maximum about 9 or 9.30 A.M., and its absolute minimum between 4 and 5 P.M.

This may be taken as a general description of the phenomena as exhibited in the tropics, but it presents many striking variations at different places, and at one and the same place at different times of the year. These variations affect—the hour at which the pressure attains its maximum and minimum values, the absolute amplitude of the oscillations, and lastly, their relative amplitude. It is this phenomenon—the variation in the relative amplitude of the day and night oscillations—the probable physical explanation of which I have now to bring to notice.

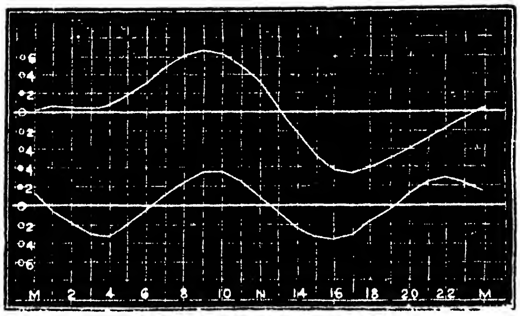
It was observed by Arago, apparently some years prior to 1841, that in Europe "the proximity of the sea has the effect of diminishing the amplitude of the interval during which the diurnal fall lasts, viz., that which occurs between 9 A.M. and 3 P.M.," and considering the whole phenomenon as made up of a single and double oscillation, it may easily be shown that this interval is determined mainly by the relative amplitude of these two elements. The latest notice on the subject is given in the following extract from Mr. Buchan's Memoir, a copy of the first part of which (for which I am indebted to the author) has reached me only within the last week. In summing up the characteristics of the midday fall of pressure, he says:—"Whatever be the cause or causes on which the diurnal oscillations of the barometer depend, the influence of the relative distribution of land and water in determining the absolute amount of the oscillation in particular localities, as well as over extended regions, is very great. From the facts detailed above, it will be seen that this influence gives a strong local colouring to the results, particularly along the coasts, and that the same influence is extensively felt over the Channel, the Mediterranean, the Atlantic, and other sheets of water on the one hand, and on the other over the inland portions of Great Britain, Europe, and the other continents," and farther on he adds: "While, as has been pointed out, numerous illustrations can be adduced showing a larger oscillation over the same region with a high temperature and a dry atmosphere than with a low temperature and a moist atmosphere, the small summer oscillation on the coasts of the Mediterranean and those of the Atlantic adjoining is in direct opposition to the idea that any such conclusion is general. For over those parts of the Mediterranean and Atlantic the temperature is hottest in summer and the air is driest—so dry, indeed, that no rain, or next to none, falls; and yet there the amplitude of the oscillation now contracts to its annual minimum. On the western coasts of the Atlantic, from the Bahamas northwards to Newfoundland, the temperature is at the annual maximum, but the air is not dry, being liberally supplied with moisture, and the rainfall is generous. But with these very different meteorological conditions there occurs, equally as in Southern Europe, a diminished oscillation during the summer months in the islands and near the

[1] Possibly some coasts may furnish an exception.

coasts of North America; and in the south of Europe the oscillation reaches its annual maximum just at the season when the annual minimum occurs near the sea-coasts, even although the general characteristics of the atmosphere be substantially the same in both cases."

I am not at present aware whether Mr. Buchan has been led by these observations to any definite conclusions as to the physical cause of the variation he so clearly summarises in the passages above quoted. In the part of his memoir which has reached me all theoretical discussion is deferred. But these passages afford such remarkable confirmation of an explanation at which I arrived some weeks since, on approaching the subject from an entirely different quarter, that I do not think it necessary to withhold longer the publication of my view. If Mr. Buchan's conclusions are the same as mine, the facts that I have to bring forward will seem to afford independent confirmation of that view.

Any person glancing over a series of curves illustrating the diurnal rise and fall of the barometer cannot fail to be struck with the characteristic difference of those of places with a continental and those with an insular climate. The case of the Mediterranean described by Mr. Buchan seems, perhaps, to be an exception; but, as I



1 Diurnal oscillation of barometer at Leh in Ladakh. 2 Do. Square 3 N. Atlantic.

shall presently show, it is an exception of such a kind as most strongly to confirm the rule. The accompanying curves are striking, perhaps extreme, examples of this characteristic difference. The first is that of Leh-in-Ladakh,[1] situated in the Indus valley (the observatory being 11,538 feet above the sea), and is for the month of September. The climate is characteristically dry and the summer heat excessive, notwithstanding the elevation. The curve for Yarkand and Kashgar, still further north, and only 4,000 feet above the sea, is of similar character but smaller amplitude. The second curve figured is that for the northern half of square 3, of North Atlantic, published by the London Meteorological Office. In the former the double oscillation has almost disappeared, the nocturnal fall of pressure being represented by little more than a halt for some hours between two periods of rising pressure; and nearly the whole fall of the day takes place between 9 A.M. and 5 P.M. In the case of the Atlantic curve the day and night oscillations are almost exactly alike, the night oscillation being only slightly less than that of the day. These characteristic differences are perhaps best expressed by the ratio of the constant coefficients U' and U'' in Bessell's interpolation formula—

$$x = M + U' \sin (n\theta + u') + U'' \sin (n2\theta + u'') +, \&c.,$$

since the magnitude of U' determines the inequality, and that of U'', though variable under different conditions of climate, is so to a much less extent than the former term, and chiefly depends on the latitude. The following are the values of U' and U'' in English inches, and their ratios for the mean diurnal curves of a few stations (chiefly Asiatic). The arcs u' u'' corresponding thereto are also given :—

	U'	u'	U''	u''	$U' : U''$
		° ′		° ′	
Yarkand (9 months) ...	·0348	4 33	·0215	161 59	1·6 : 1
Leh (September) ..	·0517	343 9	·0254	143 19	2 : 1
Lucknow (year)	·0265	341 30	·0355	168 53	0·75 : 1
Hazambagh, do.... ...	·0193	349 46	·0343	145 45	0·56 : 1
Calcutta, do.	·0265	341 24	·0391	151 7	0·68 : 1
Bombay, do.	·0179	337 17	·0385	157 13	0·46 : 1
Batavia, do.	·0240	24 7	·0369	159 34	0·65 : 1
Square 3, Atlantic, do.	·0055	354 51	·0319	159 26	0·17 : 1

As a general rule the more humid the station and the smaller the range of temperature, the smaller is the value of U', and hence it has sometimes been spoken of as the temperature element of the oscillations; the double oscillation which is superimposed on it being referred by Dove, Sabine, and Herschel to the varying tension of water vapour, by Lamont and Broun to some solar influence other than heat; and by Espy and Kreil to the oscillation of pressure produced by heat in an elastic fluid expanding and contracting under the influence of gravity. To me it seems that there can hardly be a doubt that the last explanation is the true one, and that this has not been generally recognised I attribute to the fact that the consequences of the theory as a purely physical problem have never yet been traced out and verified by such a mass of facts as Mr. Buchan is now bringing together. So long as the *whole* phenomenon is not satisfactorily accounted for, some doubt may reasonably attach to the explanation offered of one only of its elements.

My own attention was first drawn to the subject of the explanation which I am about to give by a paper of Mr. F. Chambers in the *Phil. Trans.* for 1873, in which that gentleman showed, as the result of an analysis of the diurnal variation of the winds at Bombay, that one element of this variation is a double rotation of the wind direction of such a character that the southerly components attain their maximum value at the epoch of the most rapid semi-diurnal rise of pressure, the easterly components at the epoch of maximum, the northerly with the most rapid fall, and the westerly with the epoch of minimum. On these facts Mr. Chambers based a suggested explanation of the barometric tides; regarding them as a phenomenon of static pressure; and assumed (as now appears, on insufficient grounds) that the phenomenon in the northern hemisphere is generally of the same type as at Bombay. There was indeed one feature in his explanation, which it seems difficult to reconcile with mechanical laws, since he supposed air to flow from both east and west towards a region where the pressure is rising above the mean, and by its accumulation to produce a maximum of static pressure. But apart from this, the discovery was an important one, and since it clearly showed that a regular horizontal transfer of air corresponded to the oscillations of pressure, it held out a promise that further steps in the same path might clear up what appeared to be anomalous, and possibly lead to a complete explanation of the diurnal oscillation.

Some time before this paper reached me, the Rev. M. Lafont had placed in my hands four years traces of a Secchi anemograph, erected on St. Xavier's College, Calcutta, and these having been measured off, tabulated, and reduced, I was interested to find that the diurnal wind variation at Calcutta showed the double diurnal oscillation quite as distinctly, and relatively even more prominently than that of Bombay. But one important difference presented itself. The north and south elements of the oscillation, while agreeing in epoch with those of

[1] This is computed from the hourly observations, recorded during six days, by Capt. E. Trotter, R.E., and of one day by Dr. J. Scully, together with six days' observations by the latter at the hours 4 and 10 A.M. and P.M.

Bombay, were reversed in direction and taken together with the latter, showed a tendency to a cyclonic circulation of the atmosphere around the Peninsula during falling pressure, and an anticyclonic circulation with rising pressure. Moreover, the east and west components agreed almost exactly in epoch with the north and south components, the result being a movement of air from the north-west, with falling pressure, and from the south-east with rising pressure. These facts, taken in conjunction with the positions of Bombay and Calcutta, on opposite sides of the Peninsula, seemed to point to the differential conditions of land and water being probably concerned in the phenomenon. Another and not less important fact connecting the winds with the diurnal oscillation of the barometer appeared at the same time. When the wind variation was analysed by Bessel's method, there appeared an east and west oscillation of considerable magnitude, corresponding in epoch with the barometric inequality expressed by the first periodical term of the barometric formula. This was easily distinguished from the oscillation of the sea and land winds, since the latter is nearly north and south at Calcutta. At Bombay where the sun and land-breezes are nearly east and west, such an oscillation would be undistinguishable, even if it really exists.

The east and west oscillation of diurnal period indicates an outflow of air to the eastward during the daytime, an inflow from the east during the night, and the former phase of it evidently corresponds to the hot winds of the Gangetic plain and northern India, and indeed to the day-winds of the dry months of the greater part of India. They blow towards the sea from the eastward, only in the western portion of the Dakhan, Mysore, &c. This system of day-winds consists of an outflow of air from the Peninsula towards the sea on both coasts, the westerly direction greatly predominating.

The next step in the inquiry was to ascertain what general cause would operate to produce this efflux and influx of air; and the obvious suggestion was that it must consist in the differential action of the sun's heat on dry air and water.

Let V be any volume of dry air at pressure P, and absolute temperature T, and let τ units of heat be communicated to it, raising its temperature from T to $T + t$, while the volume remains constant. The pressure will be thereby increased from P to $P + p$, wherein

$$p = P\left(\frac{T+t}{T} - 1\right) = P\frac{t}{T} \qquad (1)$$

Also

$$\tau = Vs\frac{P}{P}\frac{T_0}{T}tc, \qquad (2)$$

wherein s is the density of air at the standard pressure P and temperature T_0, and c its specific heat at constant volume, compared with water as unity.

If now the same quantity of heat τ be employed in evaporating water at temperature T (the whole being consumed as latent heat), and filling the volume of air V with vapour at pressure p', the total pressure will become $P + p'$, and

$$\tau = Vs\frac{p'}{P}\frac{T_0}{T}\lambda$$

where s is the hypothetical density of water vapour at P and T_0, and λ its latent heat at temperature T. Substituting for s its approximate equivalent $\frac{5}{8}s$

$$\tau = V\tfrac{5}{8}s\frac{p'}{P}\frac{T^{\circ}}{T}\lambda \qquad (3)$$

and equating (2) and (3) and eliminating common factors,

$$Ptc = p'\tfrac{5}{8}\lambda$$

$$p' = P\frac{tc}{\frac{5}{8}\lambda} \qquad (4)$$

From (1) and (4)

$$p : p' = P\frac{t}{T} : P\frac{tc}{\frac{5}{8}\lambda}$$

$$p = p'\frac{\frac{5}{8}\lambda}{Tc} \qquad (5)$$

which gives the ratio of the increase of pressure produced by the same quantity of heat, employed in the one case simply in heating dry air, and in the other in charging it with vapour. At a temperature of 80° Fahr. = $T = 541$,

$$p = 7{\cdot}36\,p';$$

that is to say, when a given quantity of heat is employed in heating dry air at the temperature of 80° it raises its pressure more than seven times as much as when it simply charges it with vapour without altering the temperature. With lower values of T the difference will be still greater.

This great difference is no doubt much reduced in nature by the effects of radiation; and while some evaporation is effected on the land surface, there is some increase of temperature over the sea, but it may be expected that some part of this difference will manifest itself in the greater intensity of the forenoon pressure in the lower strata of the atmosphere on the land as compared with the sea, and in fine clear weather as compared with cloudy weather, when banks of clouds present an evaporating surface. With regard to this latter point, it has been shown by Lamont and Kreil's investigations, that between clear and cloudy days, there is a difference of this kind, and that it is manifested not only in the greater magnitude of the diurnal co-efficient U', but also, although to a much less degree, in that of the semi-diurnal co-efficient U'' of the barometric formula. Further evidence of the same kind is afforded by the values of these co-efficients for the several months at Calcutta.

	U'	u'	U''	u''
January	·0287	330° 18′	·0415	151° 34
February	·0319	327 12	·0423	146 48
March ..	·0343	329 27	·0437	146 44
April	·0301	336 53	·0425	146 38
May ..	·0325	344 43	·0385	148 13
June ..	·0218	357 28	·0336	146 23
July	·0192	2 6	·0396	150 30
August ...	·0218	0 5	·0372	144 29
September	·0232	354 41	·0400	151 25
October ...	·0234	343 12	·0393	160 59
November	·0250	337 38	·0399	164 22
December ..	·0270	335 18	·0411	158 55

The driest months in Northern India being March and April, while July is the wettest and most cloudy.

On Espy and Kreil's hypothesis of the cause of the double oscillation, there is no apparent reason why the evening maximum, arising from contraction and dynamic pressure, should be equal to the morning maximum, which seems unquestionably due to the increased tension of the lower atmosphere in consequence of heating and the introduction of vapour; and any inequality will, of course, appear in the value of U', or of the co-efficients of other terms of odd periodicity. But the fact established by the anemometer that an outflow of air from a heated land area takes place during the day-time, at once assigns a cause for the greater part of the equality, viz., an alteration of the static pressure. This is not an overflow in the upper regions of the atmosphere, but an outflow of the lower strata, or a tendency in that direction. It does not, of course, follow that to produce a reduction in the mass of air over a continent, there should be an actual motion of the air outwards in all directions. The very small forces in action will be manifested even more in retarding in-flowing currents than in accelerating efflux; and it is only in very dry and highly-heated regions, such as India, that they produce well-marked diurnal surface winds, blowing outwards towards the sea;

winds of elastic expansion, such as are the hot winds of India and Australia, winds which are distinct from convection currents, though, it may be, coexisting with and accelerating them. The relations of these winds to the barometric tides are very marked, but it does not seem that the differences of tidal pressure would suffice to generate them, were there not a movement of the air in the same direction arising from more persistent differences of pressure. They probably also depend much on local and irregular differences of pressure.

The air thus removed in the day time from continental areas must, of course, collect over the nearest areas of evaporation, with the effect of diminishing the mid-day fall of pressure over those tracts, and thus seem to be explained those apparent anomalies in the magnitude of the mid-day semi-oscillation of the barometer to which, in the passages quoted from Mr Buchan's memoir, he has drawn attention, viz., in the case of the Mediterranean area and the Atlantic coast of North America.

The direction in which this movement of the air takes place will, of course, vary with the locality, but there will always be, on an average, a greater diurnal movement towards coasts than towards the east or to the west. This may be illustrated by the case of Calcutta and Bombay, and it is more extensively illustrated by the predominant westerly direction of the hot winds of India and the cold westerly diurnal winds[1] that blow across the high plains (17,000 to 19,000 feet) of the Chang-thenmo and Rupshu in Western Tibet. Here ... sufficiently obvious. As the ... of pressure ... from east to west, the local barometric gradient of any place (in so far as it is determined by the diurnal oscillation) will be expressed by ... the existing phase of the wave. During the hottest part of the day, viz., from ... past 9 ... past 4 or 5, this gradient (which is the steepest and most prolonged of the ...) inclines to the eastward, and increases the declivity towards east coasts rising from the excess of pressure over the land. In the opposite direction, viz., towards west coasts, it goes to diminish that declivity. At night the ... reversed. The west to east barometric gradient from 10 P.M. to half-past 3 or 4 A.M. is in the same direction as that tending to produce ... from the sea towards the land on west coasts; this, however, is opposed to the land wind of the coast line, which is a true convection current, and arises from quite different causes; and, although traceable in the wind variation at Bombay, it there manifests itself only by decreasing the velocity of the former. There are, moreover, independent grounds for the inference that this compensating flow chiefly affects the higher strata of the atmosphere, while the day wind is chiefly produced in the lower and more heated strata. At Calcutta the easterly (or rather westerly) tendency of the wind at night is very prominently exhibited in the curve of diurnal variation, but although of longer duration it is not nearly so intense as the westerly tendency in the early afternoon hours.

In like manner may be explained the difference of epoch of the corresponding phases of the semi-diurnal east and west variation at Calcutta and Bombay. The gradient of pressure, in so far as it depends on the semi-diurnal oscillation, will, of course, be to the west with a rising pressure, and to the east with a falling pressure, and this normal tidal gradient is affected by the small difference of amplitude over land and sea, in such manner that its changes will be accelerated as affecting east coasts, and retarded as affecting west coasts. Now if we suppose that the acceleration in the one case and the retardation in the other amount to an hour or an hour and a half, and that the interval between the change in the direction of the gradients, and their effects on the wind, as manifested by the anemometer, is also about an hour and a half, we should roughly reproduce the conditions shown to exist at Calcutta and Bombay respectively.

According to this view, the local static pressure of the atmosphere, apart from irregular movements, is shown by the height of the barometer at the hours of minimum pressure, and the difference of these expresses the weight of the atmosphere removed and restored by the oscillatory movements chiefly between land and sea.

I should add, in conclusion, that this communication is merely a *résumé* of some of the more salient topics discussed in two papers, "On the Winds of Calcutta," and "The Theory of Winds of Elastic Expansion," which will shortly be published *in extenso* elsewhere.

H. F. BLANFORD

[1] This I state on the authority of Dr Cayley, who assures me that on the high plains the afternoon winds are always from the west.

CARBONIFEROUS LAND SHELLS

In a recent visit to the South Joggins, in Nova Scotia, in which I was assisted in the examination of the cliff by Mr Albert J. Hill, Manager of the Cumberland Coal Mine, we found a number of well preserved shells of *Pupa vetusta*, in the indurated clay, filling an erect Sigillaria, in a bed considerably higher than those in which the shell was previously known. It is nearly in the middle of group xxvi. of my section of the South Joggins, 222 feet above the main coal seam, 842 feet above the bed in which the species was first recognised by Sir C. Lyell and myself, and about 2,000 feet above the lowest bed in which I have yet found it. It thus appears that this little pulmonate continued to flourish in the carboniferous swamps, after its remote ancestors had been covered with 2,000 feet of sediment, including many beds of coal, and nearly the whole thickness of the productive coal measures. *Conulus priscus*, the only other land snail found in this section, on the other hand occurs only, so far as known, in the lowest of the beds above mentioned. Two other carboniferous land shells, *Pupa vermilionensis*, Bradley, and *Dawsonella Meeki*, Bradley, have been found in the coal field of Illinois, and it is worthy of remark that, according to Dr P. P. Carpenter, all the four species belong to distinct generic or sub-generic forms, and that all these forms are still represented on the American Continent.

On the same visit, we were so fortunate as to find another large Sigillarium stump, rich in reptilian remains, which it is hoped may, on examination, afford new species and further information on those already known.

J. W. DAWSON

THE BIRDS OF KERGUELEN'S LAND[1]

As regards the publication of results achieved by the naturalists accompanying the recent Transit expedition, our American friends appear to be getting the start of us. While we are engaged in issuing "preliminary reports," they have already arranged and classified their collections, and are beginning to publish their discoveries. The specimens of birds obtained by Dr Kidder, surgeon and naturalist attached to the astronomical party at Kerguelen's Land, or Desolation Island, have been placed for determination in the hands of Dr E. Coues, one of the most competent zoologists in the United States, and the result has been the very interesting memoir now before us. We knew already that Kerguelen's Land was not an inviting place of residence for the more highly organised animals, and that few birds were to be found there. We know now what those few are, and have full particulars about most of them, their lives, and habits. According to Dr. Coues' determination, Dr

[1] "Bulletin of the United States National Museum," No. 2. Contributions to the Natural History of Kerguelen Island, made in connection with the American Transit of Venus Expedition, 1874-75. By J. H. Kidder, M.D. I. Ornithology. Edited by Dr Elliott Coues, U.S.A. 8vo. 52 pp. (Washington, 1875.)

Kidder's collection contains examples of twenty-one species of this class, belonging to six families, namely, eleven Petrels, four Penguins, three Gulls, a Cormorant, a Duck, and a Sheath bill. Of these, the two last-named are "the only partial vegetable feeders observed, all the other birds feeding exclusively on flesh, fish, or marine invertebrates." Of the *Chionis*, or Sheath-bills, a singular abnormal form related to the Plovers, of which there are (or were lately) living specimens in the Zoological Society's Gardens, Dr. Kidder might well have sung, in the words of the old song, "their tameness is shocking to me." "They would scarcely get out of my way," says the Doctor, "and seemed greatly interested in my movements. When I sat on a stone, keeping perfectly still, the whole party, twelve in all, came up to examine the intruder. They walked all around me, coming almost within reach, others flying up from more distant rocks to join them, and finally stopped, almost in a semi-circle, for a good stare. After watching the birds for a time, I shot four specimens, not without compunction on account of killing such trustful acquaintances. When I walked off to get a sufficient distance away for a shot, the whole troop started to follow me, making little runs and stopping, as if filled with curiosity. I shot all four without moving from the spot, reloading for each, the birds not all flying out of range even after the gun had been fired. On subsequent occasions, various members of the party captured specimens by hand, all that was necessary to attract them within reach being to remain perfectly still. After one had been caught it served as a lure for others. When taken home alive they still showed no fear, but when let loose in the house took food readily."

Another curious fact observed is that in the absence of true birds of prey in Kerguelen's Land, the Skua of the Southern Seas (which Dr. Coues, widely departing from the ordinary binomial system designates as "*Buphagus skua antarcticus* (Less.), Coues"), appears to have taken upon itself all the habits and practices of a Buzzard or Kite. "It was at first taken for a hawk by all of us, its manner of flight, watchfulness of the ground over which it flew, and habit of perching on spots commanding a wide view, all suggested this impression. It was, indeed, difficult to believe the evidence of my own senses when I found a web-footed bird avoiding the water and preying solely, so far as my observations extended, upon other birds. When any of the party went out shooting he was pretty sure to be followed by one or two 'sea-hens,' as the sealers call them, and had often to be very prompt to secure his game before it should be carried off in his very presence."

Many details are likewise given respecting the habits of the other nineteen species observed, and great credit is due to Dr. Kidder and Dr. Coues for the speedy manner in which they have put together this interesting memoir. But what Mr. Eaton, the English naturalist at Kerguelen, and Mr. Sharp, who, we believe, has been, or is working out his birds, will say to it, we cannot tell. We fancy they will not be very much pleased at being thus forestalled.

MAYER'S RECENT ACOUSTICAL RESEARCHES[1]

THIS communication is merely a preliminary note, to be followed by an elaborate paper on the above subjects. For conciseness and clearness, I present the few facts I have now to offer in the form of notes of experiments:—

[illegible] Obliteration of one Sound by another.—Several feet from the ear I placed one of those loud ticking spring-balance American clocks, which make four beats in a second. Then I brought quite close to my ear a watch (made by Lange, of Dresden) ticking five times in the second. In this position I heard all the ticks of the watch, even those which coincided with every fourth tick of the clock. Let us call the fifth tick of the watch which coincided with one of the ticks of the clock, its fifth tick. I now gradually removed the watch from the ear, and perceived that the fifth tick became fainter and fainter, till at a certain distance it entirely vanished, and was, so to speak, "stamped out" of the watch.[1]

Similar and more striking experiments were made with an old silver watch, beating four times to the second, by causing this watch to gain about thirty seconds an hour on the clock, so that in every two minutes the ticks of the watch and clock exactly coincided. When the watch was held near the ear, every one of its ticks was heard distinctly, but on gradually removing it from the ear, the ticks of the watch became fainter and fainter at the coincidence, and when the watch had been removed to a distance of nine inches from the ear, the ticks of the watch were utterly obliterated during *the* whole seconds of its ticks about the time of coincidence. On removing the watch to a distance of twenty-four inches, I found that I lost its ticks during *nine* seconds about the time of coincidence. It is here important to remark that the ticks of the clock are *longer* in duration, as well as *lower* in pitch, than those of the watches. With the watch remaining at the distance of twenty-four inches from the ear, I listened with all my attention, as tick by tick the watch approached the time of coincidence. Since the ticks of the watch are shorter in duration than those of the clock, they are *[illegible]* by the latter about the time of coincidence. Hence as, so to speak, the short ticks of the watch glided, tick after tick, under the long ticks of the clock, I perceived that more and more of the duration of each successive watch tick became extinguished by the tick of the clock, until only the *front* end of the short tick of the watch was left audible, and at last even this also crept under the long tick of the clock, and the whole of the ticks of the watch were rendered inaudible for *nine* seconds, at the end of which time the front or *head* of the watch tick, as we may call it, protruded beyond the clock tick, and then slowly grew up into a complete watch tick as before. In this succession of events the ticks of the old silver watch (made by Tobias) disappears with sharp *[illegible]*, like a circlets, and reappears with a [illegible] that made by [illegible] inaudible [illegible] falling upon others in [illegible] of this [illegible] the fore, a careful analysis is made of the effect of the tick of the clock on the tick of the watch, affording a beautiful illustration of the fact that one sonorous sensation may overcome and obliterate another.

Experiments to determine the relative intensity of the [illegible].—The clock was placed on a post in the middle of an open level field in the country, on nights when the air was calm and noiseless. The ticks of the clock became just inaudible when my ear was removed to a distance of 550 feet. The ticks of the watch became just inaudible at a distance of twenty feet. The ratio of the squares of these numbers makes the ticks of the clock about 500 times more intense than those of the watch. On the same nights that I made the above determinations I also put the clock on the post, and placing against it my zygomatic process a slender stick graduated to inches and tenths, I stood with my ear at distances from the clock of from eight to sixteen feet, and then slid the watch above and along the stick (taking care that it did not touch it) until it reached such a distance from the ear that its fifth tick just disappeared. Knowing the relative intensities of the ticks of clock and watch when placed at the same distance from the ear, the law of the reciprocals of the squares gives the relative intensities when the clock and watch are at the several distances obtained in the above experiments. Large numbers of such experiments have been made, and the results agree perfectly well when we take into consideration first, the difficulty

[1] On the Obliteration of one Sonorous Sensation by the simultaneous action of another more intense and lower Sound; and on the discovery of the remarkable fact that a Sound, even when very intense, cannot obliterate the sensations of another Sound Lower than it in Pitch; with Applications of these Discoveries to Measures of the Intensities of Sounds and to the Proper Method of Conducting Orchestral Music. By Alfred M. Mayer, Ph.D., Member of the National (American) Academy of Sciences, and Professor of Physics in the Stevens Institute of Technology, Hoboken, New Jersey, U.S. America. Read before the National (American) Academy of Sciences, in Washington, April 20, 1876, and now first printed from the manuscript sent through Mr. Alex. J. Ellis, F.R.S.

[1] The precise numbers of ticks in a second here mentioned are not necessary for readily observing and understanding these phenomena. I observed them by a common American pendulum clock placed on a table, which increased the power of its half second ticks, and a watch beating five times in two seconds. Rev. Mr. Haweis informs me that he has often noticed a similar effect at night with ordinary watches. The sensation produced by the obliteration of the tick when the proper distance of the watch from the ear has been attained and the consequent sudden division of the ticks into periods separated by silences is very peculiar. It is difficult not to believe that some accident has not suddenly interfered with the action of the watch, instead of merely with our own sensations.—A. J. E.

thrown in the path of the determinations by the *gradual* fading away of the watch-ticks as they approach coincidence with the clock-ticks; and, secondly, the impossibility of arriving at *any* result at all, if the slightest noise (the rustle of a gentle breeze, the piping of frogs, the bark of a distant dog) should fall on the ear of the observer when engaged in making an experiment. The general result of the numerous experiments thus made shows that the sensation of the watch-tick is obliterated by a coincident tick of the clock, when the intensity of the clock-tick is *three times* that of the watch-tick. This result, however, must be regarded as merely approximative, not only from the manner in which it was obtained, but from the *complexity* of the sounds on which the experiments were made. It is interesting, however, both as being, I believe, the first determination of this kind that has ever been made, and as having opened out a new and important field of research in physiological acoustics.

Experiments on Musical Sounds.—Reserving the further development of my discoveries to a future paper, I will now briefly describe some of the more prominent and simple phenomena, which I discovered in experimenting with *musical sounds*. At the outset I will remove an objection always made by those versed in acoustics, but unacquainted with these new phenomena. It is as follows:—"You say that one sound may obliterate the sensation of another; but are you sure that the real fact is not an alteration of the *quality* of the more intense sound by the action of the concurrent feebler vibration?" I exclude this objection by experimenting as follows:—An open or closed organ-pipe is sounded forcibly, and at a few feet from it is placed the instrument emitting the sound to be obliterated, which may be either a tuning-fork on its resonance box, or a closed organ-pipe communicating with a separate bellows. Suppose that in the following experiment both tuning-fork and closed organ-pipe produce a note higher in pitch than the more intense or extinguishing sound of the open organ-pipe. Now sound the fork alone strongly, and alternately shut and open its resonance box with the hand. We can thus obtain the sound of the fork in a *regular measure of time*. When the ear has well apprehended the intervals of silence and of sound thus produced, begin the experiment by sounding the open pipe and tuning-fork simultaneously. Now, if any change is thus effected in the quality of sound emitted by the open pipe, this change cannot occur except when the pipe is sounding, and hence, if it occurs at all, it must occur in the regular measure in which the fork is sounded. The following are the facts really observed. At first every time that the mouth of the box is open, the sound of the fork is distinctly heard, and changes the quality of the note of the open pipe. But as the vibrations of the fork run down in amplitude, the sensations of its effect become less and less, till they soon entirely vanish, and not the slightest change can be observed in the quality or intensity of the note of the open organ-pipe, whether the resonance box of the fork be open or closed. Indeed at this stage of the experiment the vibrations of the fork may be suddenly and totally stopped without the ear being able to detect the fact. But if instead of stopping the fork when it becomes inaudible, we stop the sound of the open organ-pipe, it is impossible not to feel surprised at the strong sound of the fork which the open pipe had smothered and had rendered powerless to affect the ear. If we replace the tuning-fork by a closed organ-pipe of the same pitch, the results will be the same, but in this case I adjust the intensity of the higher closed pipe to the point of extinction by regulating the flow of air from the bellows, by a valve worked with a screw. The alternation of sound and silence is obtained by closing and opening the mouth of the closed pipe by the hand.

High Sounds cannot obliterate Low Sounds. A new and remarkable fact was now discovered. No sound, even when very intense, can in the slightest degree diminish or obliterate the sensation of a concurrent sound which is lower in pitch. This was proved by experiments similar to the last, but differing in having the more intense sound higher (instead of lower) in pitch. In this case, when the ear decides that the sound of the (lower and feebler) tuning-fork is just extinguished, it is generally discovered on stopping the higher sound, that *the fork*, which should produce the lower sound, *has ceased to vibrate*. This surprising experiment must be made in order to be appreciated. I will only remark that very many similar experiments have been made, ranging through four octaves, and have been observed by a score of different ears, with the same invariable result. It is important to understand that this phenomenon depends solely on the *difference* of pitch, and not at all on the absolute pitch of the notes. Thus a feeble c''' (1024 double vibrations) is heard as distinctly through an intense e'' (1280 double vibrations) as a feeble c (128 double vibrations) is heard through an intense g (192 double vibrations) or an intense c' (256 double vibrations).

The development of the applications and of the further illustrations of these discoveries would occupy too much space; I must therefore restrict myself to mentioning some of the most interesting. Let a man read a sentence over and over again with the same tone and modulation of voice and while he is so doing forcibly sound a c' pipe (256 double vibrations). A remarkable effect is produced, which varies somewhat with the voice experimented on, but the ordinary result is as follows. It appears as though two persons were reading together, one with a grave voice (which is found by the combination of all the real reader's vocal sounds below c' in pitch, or having less than 256 double vibrations), the other with a high-pitched voice, generally squeaky and nasal, and, I need not add, very disagreeable. Of course the aspirates come out with a distressing prominence. I have observed many curious illustrations of this change in the quality of the tone of the voice, caused by the entire or partial obliteration of certain vocal components, while listening to persons talking during the sound of a steam-whistle, or in one of our long, resonant American railway carriages. Experiments similar to those on the human voice, can be made, with endless modifications, on other composite sounds, as those of reed-pipes, of stringed instruments, of running water, &c. With one of my c (128 double vibrations) free Grenié reeds, I get very marked results. Using as a concurrent sound an intense c' (256 double vibrations) I perceive the prime or fundamental simple tone c to be unaffected in intensity, while all the other partial tones (higher harmonics or overtones, as they are sometimes called) are almost obliterated, except the fifth partial (or fourth upper partial) e'', of 640 double vibrations, and the sixth partial (or fifth upper partial) g'' (of 768 double vibrations), which come out with wonderful distinctness. The fact that the lowest, or prime partial tone in the majority of ordinary compound musical tones is the strongest, is due (among other reasons) to the fact that the sensation of each partial tone of which the whole musical tone is composed, is diminished by the action on the ear of all the components or partial tones, *below* it in pitch. Thus the higher the pitch of any component or partial tone, the greater the number of lower components which tend to obliterate it. But the prime, or lowest component partial tone, is not affected by any other. Another illustration I cannot resist giving. At the end of the street in New York, in which I now reside, there is a large fire-alarm bell, the residual sound of which, after its higher components have disappeared, is a deep simple tone. This bass sound holds its own with total indifference to the clatter of horses, or to any sounds *above* it in pitch. It dies out with a smooth gradient, generally without the slightest indentation or break produced by the other sounds of the street. Indeed in this case, as in all others where one sound remains unaffected by intense higher notes, the observer feels as though he had a special sense for the perception of the graver sound—an organ entirely distinct from that which receives the impress of the higher tones.

That one sonorous sensation cannot interfere with another which is lower in pitch, is a remarkable physiological discovery, and next after the demonstration of the fact that the ear is capable of analysing compound musical sounds into their constituent or partial simple tones, is probably the most important addition yet made to our knowledge of the nature of hearing. It cannot fail to introduce profound modifications into the hypotheses heretofore framed respecting the mechanism and functions of the ear.

Application to Orchestral Performances.—We have seen how an intense sound may obliterate, entirely or in part, the sensations of certain partial tones or components of any musical tone, and thus produce a profound change in its quality. In a large orchestra I have repeatedly witnessed the entire obliteration of all sounds from violins, by the deeper and more intense sounds of the wind instruments, the double-basses alone holding their own. I have also observed the sounds of the clarinets lose their peculiar quality of tone and consequent charm from the same cause. No doubt the conductor of the orchestra heard all his violins, ranged as they always are close around him, and did not perceive that his clarinets had lost that quality of tone on which *the composer* had relied for producing a special character of expression.

The function of the conductor of an orchestra seems to be threefold. First, to regulate and fix the time. Secondly, to regulate the intensity of the sounds produced by the individual instruments, for the purpose of expression. Thirdly, to give the

proper quality of tone or *klang*, to the whole sound of his orchestra, considered as a single instrument, by regulating *the relative intensities* of the sounds produced by the various classes of instruments employed. Now this third function, the regulation of relative intensities, has hitherto been discharged through the judgment of the ears of a conductor who is placed in the most disadvantageous position for judging by his ears. Surely [illegible] conducting [illegible] his own personal gratification, but for the gratification of his audience, whose ears stand in very different relations from his own in respect to their distance from the various instruments in action. Is it not time that he should pay more attention to his third function and place himself in the position occupied by an average hearer? This position would be elevated, and somewhere in the midst of the audience. The exact determination of its place would depend on various conditions which cannot now be considered. That the position at present occupied by the conductor of an orchestra has often allowed him to deprive his audience of some of the most delicate and touching qualities of orchestral and concerted vocal music I have no doubt, and I firmly believe that when he changes his position in the manner now proposed the audience will have some of that enjoyment which he has so long kept to himself. During the past winter, in the Academy of Music at New York, I fully confirmed all the foregoing surmises, by placing myself in different parts of the house to observe the different results, and my opinions were fully shared by others who have a more delicate musical organisation than I can lay claim to.

In large orchestras, these interferences of sonorous sensations are so multiplied and various as to be beyond our mental conception. By taking them up in detail, some general laws may, however, be evolved. But it will be impossible to formulate such laws until, firstly, we are in possession of *quantitative* analysis of the compound tones of all musical instruments (that is, until we know the relative loudness of the partial tones of which they are composed at all parts of their compass), and secondly, we have determined throughout the musical scale the relative intensities of the sounds (or simple tones) when obliteration of the sensations of higher (simple) tones supervenes. The powerlessness of one sound to affect the sensation due to another sound lower than itself in pitch, greatly simplifies this problem.

Quantitative analysis of the compound tones of musical instruments is now the great desideratum of the composer. It is only after we know the relative intensities of the components of typical musical tones used in orchestral performances, that we can so regulate their intensities as to give the qualities of sound which the composer desires to be heard. Thus, it at once becomes evident that the instruments used in orchestral music should be very differently constructed from those used for solos or quartets. In orchestral instruments certain *dominant* upper partials (overtones, harmonics) should predominate, in order to find expression in the midst of other and graver sounds. Such orchestral instruments will therefore have exaggerated peculiarities in their qualities of tone, which will render them unfit to be played on alone, and uninfluenced by other orchestral notes. It is surely not hopeless to anticipate that empirical rules may be attained, which will guide the musical instrument maker to the production of those special qualities of tone required in orchestral instruments. It is fortunate that the very phenomena of the interferences of sonorous sensations will assist in the much desired solution of the problem of measuring the intensity of a sound (simple tone), either when existing alone or as component of an ordinary musical (compound) tone. On this subject I am now engaged. It is evident (by way of illustration), that so far as concerns the measure of the relative intensities of sounds *of the same pitch*, this problem has already received the simplest solution by merely placing these sounds at various distances, and obliterating the sensations they excite by means of a constant and standard sound of a lower pitch. But I reserve a description of this work for a more formal publication.

NOTES

PROF. HUXLEY, who has recently left for America, has accepted an invitation from Prof. W. B. Rogers to attend the Buffalo meeting of the Association for the Advancement of Science, and also to deliver a course of lectures before the Johns Hopkins University. His stay, however, in the country will be but short.

THE Academy of Sciences of the Institute of Bologna announces an open competition for the Aldini Medal, to be awarded to the author of the memoir of greatest experimental and scientific value in galvanism. The medal is of gold, of the value of 1,000 lire, and is open to all works which profess to have extended our knowledge in any department of galvanism, and which may be sent to the Academy expressly for the competition, during the two years comprised between June 1, 1876, and May 30, 1878. Memoirs must be written in Italian, Latin, or French. The usual conditions of such competitions are to be observed, and memoirs should be sent in before the last mentioned date, addressed "Al Segretario perpetuo dell' Accademia delle Scienze dell' Istituto di Bologna."

WE notice in the *Revue Scientifique* further particulars regarding the meeting of the French Association for the Advancement of Science, to be held at Clermont Ferrand on the 18th inst. A list of the papers to be read is also given. This is a very useful arrangement for those who may anticipate taking part in the proceedings, and others, and might with advantage, we think, be copied in this country. In the group of physics and chemistry we note the following among the subjects to be treated:—Diffraction in optical instruments, new volumetric determinations of arsenic, new salts of bismuth, experiments made to determine if the ether is ponderable, observation in celestial and terrestrial physics in Japan and Siam (by M. Janssen), thermo-diffusive properties of gas, on the idea of unity in chemical and cosmic phenomena, the actinometer, &c. In the group of natural sciences:—Vichy waters, from a physiological and hygienic point of view, recent prehistoric discoveries in [illegible], animal heat, influence of the want of air and light in the streets and houses on health, function of leaves and roots of plants in tropical countries, cure of paralysis by continuous currents, operation for cataract, the bite of vipers, ophthalmia in the North of Africa, proof of the existence of ferment germs in the organism as in the air, a new æsthesiometer, production of phenomena of synthesis in plants, sporadic and endemic goitre in Puy de Dôme, on measles in beef and [illegible] tænia, resources of France as regards war horses, various points in local archæology, geology, palæontology, &c. In the group of economical sciences:—Teaching of living languages, from the economical point of view, remedies for phylloxera, depopulation of the country and emigration to America, workmen's dwellings and morality of France, economical consequences of the war indemnity, &c., &c.

THE storm of August 3 will be long remembered not only as being about the heaviest summer gale that has occurred for many years, but also as having been most disastrous to life and property among the fishing population. It broke out on the fishermen on the east coast just when their nets had been shot for the night at distances of twenty miles, and upwards, out at sea. The value of the nets lost at Aberdeen alone is estimated at 4,000*l*. The rate of the fall of the barometer being nearly an inch in twenty-four hours, the point to which it fell being about 29·0 inches at sea-level over a wide district in the north, the time during which it remained low, and the large and comparatively rapid rise which followed are rather the characteristics of our more marked winter storms. A storm of this nature is, therefore, deserving of a very careful investigation, chiefly with the view of ascertaining how far it might have been possible to have given the fishermen some intimation beforehand of its peculiarly destructive character.

IN the *Bulletin International* of August 3, M. de Tastes relates some interesting particulars of a waterspout (*trombe*) which was observed near Tours, on May 25, 1876. It first appeared as a mass of white vapour against a background of

dark-coloured clouds, which gradually assumed the form of an inverted cone pointing to the ground, and terminating in a long sinuous band. A whitish sinuous column soon appeared suddenly between it and the ground, and rapidly enlarged upwards, the whole phenomenon soon assuming the appearance of two cones united at their summits. The lower cone, at first lightish-coloured and in a certain degree transparent, gradually assumed a darker shade, which was propagated from the base towards the summit. When passing over the right bank of the Loire, a dense mass of sand, mud, and fine gravel, was observed drawn towards it; in crossing the river a *jet d'eau* broken into spray appeared in the form of a cone ascending the waterspout, with its base resting on the water, the spray on all sides being drawn inwards towards the axis in spires. It is said that an undefined glimmering appearance preceded the column of ascending spray. On reaching the extensive sandy shore of the left bank, clouds of sand were drawn violently in upon it, just as happened with the spray of the river. From the value of several of these points in the theory of waterspouts and other aerial movements, it is desirable, as opportunity offers that they be tested by observations made with the greatest accuracy and skill.

MR. F. E. NIPHER writes to the *American Journal of Science and Arts*, that not long since, while writing logarithms that were being read to him, he observed that the probability of error in writing the numbers appeared to be much less at the extremities of the number than in the middle. This he investigated at length in numbers of from five to ten digits. It was found that the probability of error is in all cases expressed by the terms of the expanded binomial $(a + b)^n$, where n is a function of the number of digits. a and b were, so far, always unequal with all the persons that had been experimented on. The probability of error is greatest just after the middle of the number. This led to an interesting investigation on the power of memory. Allowing definite intervals (t) of time to elapse between the giving and the writing of the number, it is evident that the number of errors will increase with the value of t. In order to aid the experimenter in abstaining from mentally repeating the number which he is to write, he is allowed to determine the value of t by counting the beats of a seconds pendulum. The investigation is yet in progress, but enough has been done to develop the fact that the relation between the number of figures (per 100) written correctly, and the values t, is a logarithmic one. It is the same as the function expressing the decrease in the amplitude of the beats of a pendulum in time, as due to a resisting medium.

WE learn from the same journal that the trustees of the Massachusetts Society for promoting Agriculture have offered some very handsome prizes for special plantations within the State of Massachusetts. In the first place, for the best plantation of not less than five acres of larch, or on the Cape, &c., of Scotch or Corsican pine, originally of not less than 2,700 trees to the acre, on poor, worn-out, or otherwise agriculturally worthless land, a prize of $1,000. For the next best, a prize of $600; for the third best, $400. Next, for the best plantation of the same extent with American white ash, not less than 5,000 trees to the acre, a prize of $600; for the next best, $400. Intending competitors must notify the Secretary of the Society, E. W. Perkins, Jamaica Plain, Boston, as early as December 1, 1876, and plant in the spring of 1877. Special directions, not only for planting and caring for, but also for procuring trees for the purpose, are given in a recently-published pamphlet by Prof. Sargent, of Harvard, "A Few Suggestions on Tree-planting," which the Society has reprinted for gratuitous distribution; and a citizen of Boston patriotically offers to look after the importation of the seedling trees, which, in such quantities, and for next year's planting, would have to be obtained mainly in Europe, at least the pines and larches. The ashes, probably, would have to be raised from seed; and the time, if need be, would doubtless be extended. The prizes are to be awarded in the summer of 1877.

AMONG various experiments with the radiometer which have lately been described to the French Academy, is one in which M. Govi inclosed a very sensitive instrument (the vanes of which were of polished aluminium on the one side and blackened mica on the other) in a glass cylinder, into which was continuously passed steam from boiling water. The radiometer began quickly to rotate (the aluminium face first) immediately the steam commenced to raise the temperature of the inclosure. Ere long, however, the temperature becoming invariable, the rotation diminished, and after a few minutes ceased altogether. On stopping the entrance of steam, the instrument rotated anew, but in the opposite direction, and did so for a long time before stopping. Every motionless radiometer, M. Govi points out, is like the instrument stopped at 100° in the above experiment. To make it turn in the inverse direction, you have merely to put it in a vessel of cold water; the black faces then move first, and the instrument only stops after a new state of thermal equilibrium has been established. On being brought out of the cold water it turns as though it were struck by light, although it may be in complete darkness. A radiometer motionless in the inclosure at 100°, or at zero, will turn anew if the light of a bright flame be directed on the blackened face of its vanes; "because in both cases the light absorbed by the blackened face then becomes heat, which is added to that which the vanes possess already, and may consequently further liberate gas from them." In an experiment described by M. Ducretet, ether is poured on the envelope of a radiometer which moves with *direct* rotation (black surfaces repelled) in moderate daylight. The motion is arrested and changed to that in the *inverse* direction. This reaction presently ceases, and the vanes resume the original *direct* motion, notwithstanding the evaporation maintained on the envelope by a light sprinkling of ether. The rotation now becomes more rapid than it was at first, the evaporation apparently acting as a source of heat, and yet the lowering of temperature through evaporation is very perceptible. When the sprinkling with ether ceases, the motion resumes its normal velocity and remains *direct*. M. Ducretet also tried the effect of phosphorescent powders on the radiometer, but got no motion.

THE number of visitors to the Loan Collection of Scientific Apparatus during the week ending August 5 was as follows:—Monday, 2,051; Tuesday, 3,377; Wednesday, 488; Thursday, 411; Friday, 441; Saturday, 3,422; total, 11,120.

AN interesting contribution to the study of the eye affection known as neuro-paralytic keratitis, by Dr. Decker, has just appeared in the *Archives des Sciences*. He arrives at the following conclusions:—(1) It is not an ordinary traumatic keratitis. (2) It results from the combined action of two orders of things, *a*. determining causes, which are the exterior modifying agents; *b*. a predisposing cause, consisting in diminution of the resistance of the eye, the most exposed parts of which (cornea), become easily altered by the determining causes. (3) This vulnerability is the result of lesion of nerve fibres in the internal side of the trigeminus. 4. These are neither sensitive nor vasomotor nerves. 5. The hypothesis that they are trophic nerves best accounts for the facts observed. 6. Anatomically, neuroparalytic keratitis consists of a primary necrosis of the central part of the cornea (if the latter be left open), followed in a short time by a secondary inflammation of the peripheric parts, and of the conjunctiva.

MM. BECQUEREL give a brief notice in the *Bulletin Hebdomadaire*, No. 456, of the Scientific Association of France, of the observations of temperature made at the Museum of

Natural History, during 1875, with electric thermometers placed in the air, and in soils covered with grass and soils cleared of vegetation. From the results of the last four years, it is shown that the mean annual temperature of the two soils, at a depth of 39 inches, and that of the air, is nearly alike; that at depths of from 4 to 24 inches the influence of vegetation is to raise the annual mean 0°·7 above that of soils clear of vegetation; and that during these four years the temperature of soils covered with grass or any other vegetation has not fallen to freezing (32°), a fact of no little importance to horticulture.

EXPERIMENTS were made at Paris recently, before M. Baron, Director of the Electric Telegraph, on a new system for dividing the electric light. A single generator has fed with an admirable regularity not less than eighteen lamps, having each a power equal to 100 gas-jets. The effect was wonderful, and the apparatus will be tried shortly at the Lyons railway terminus. The principle is very simple, and was discovered by a working shoemaker. The current derived from a Gramme machine, slightly modified, is sent to a second machine, which rotates before forty-eight electro-magnets, four of these electro-magnets having a force sufficient to give a light equivalent to 100 gas-jets. Twelve electric lamps can be fed at any distance. By a very simple commutator any number of these twelve lamps can be grouped together, so that one, two, or more can be set in the same apparatus. Twelve working on the same point give a real burning sun. The force required for working both machines (the prime mover and the distributor) is derived from a 4 horse-power steam-engine. The experiments at the Lyons railway will be tried with sixteen lamps and an engine of from 6 to 7 horse-power. The light will be equal to 1,600 gas-jets.

THE French Society of Agriculture and Insectology will, as usual, hold its bi-annual exhibition at the Orangerie des Tuileries in September. The exhibition being universal, some contributions are expected from England. The last having been a success, left a large surplus in the hands of the Society, which will enlarge the scale of its operations.

SOME details regarding the malacological fauna of the Island of Saint Paul have been furnished by M. Velain, in a note to the French Academy, and will doubtless interest zoologists. Little was previously known of this fauna. The island, it is known, is more than 500 leagues distant from any continents, and the tranquil lake in the old crater of the volcano seemed likely to favour the development of embryos brought by oceanic currents. The list of Gasteropoda and Lamellibranchia comprises forty species, distributed in twenty-nine genera, five of which are new. This fauna, notwithstanding the small latitude of the island, is remarkable for its austral forms. The species are mostly of small size, rarely exceeding 3 mm.; among them appear as a giant the Ranella described by Frauenfeld, which sometimes reaches 8 cm. in height. The island may be said to have two distinct fauna, that of the interior of the crater and that of the exterior; the latter is less rich; the abrupt sides, environed with reefs on which the sea incessantly breaks with violence, being hardly favourable to the thriving of marine molluscs. The species here have short, rounded forms, with thick shells. Within the crater the littoral zone is extraordinarily rich in individuals, though not in species. The conditions are: a rocky bottom exposed to the light, weak pressure, temperature kept nearly constant by thermal springs (13° to 14° C.), agitation almost *nil*, marine vegetation extremely abundant. As for deep fauna, there is none of it; the abundant liberation of carbonic acid gas at the bottom of the crater prevents life being manifested below 20 to 25 metres. The deep fauna of the exterior, on the other hand, is very rich, as indicated by the shells thrown up on the beach. The fauna of Amsterdam Island is identical with that of the exterior of Saint Paul, only the proportion of the different species varies. There is, however, a gasteropod of the genus *Helix*, which is peculiar to the island.

IT was proved, a short time ago, that several kinds of seeds will germinate between pieces of ice. A full investigation of the lower limit of temperature at which plants may germinate has recently been made by M. Haberlandt (*Centralblatt fur Agricultur chemie*). The experiments were upon wheat, rye, barley, red beet, rape, lucerne, poppy, and many other seeds. Several hundred seeds were employed of each species, and every fourteen days the seeds were taken out of the ice-chest, whose temperature was kept constant between 0° and 1°, and examined in a space whose temperature was under freezing-point. In forty-five days a decided beginning of germination was observable in eight different species (which are named). In four months it had continued to progress in a minority of these; the rest had stopped. In fourteen species there was no germination. M. Haberlandt is of opinion that those seeds which can germinate at a lower temperature than others of the same species, will give plants that require a less amount of heat for their complete development than the others, and thus by artificial sowing in cold spaces a means is to hand of obtaining species soon ripe and needing little heat. Of all the seeds which had remained for four months in the ice-case, only a few were found capable of development when brought into a warmer temperature of 16° C.

A UNIVERSAL CONGRESS for hygienic purposes and salvage will be held at Brussels on the occasion of the Exhibition. The Congress will meet from Sept. 27 to Oct. 4. A French committee has been formed of M. Claude Bernard, Admiral Paris, and others. A programme of the questions that are to come before the meeting will be found in the *Sanitary Record* for August 5.

THE *Meteorologische Beobachtungen* made at the hydrographic office of the Austrian navy at Pola during June last have been received. They are interesting from the position of Pola being near the southern extremity of the peninsula at the head of the Adriatic. The hourly observations show a strongly-pronounced maximum of wind force from 11 A.M. to 6 P.M., when it is nearly double the force registered from 9 P.M. to 6 A.M. The daily variation in the direction of the wind is equally well marked. Starting from a point east of south at 5 A.M., it gradually veers to westward, the most westerly point (nearly due west) being reached at 5 6 P.M., after which it gradually shifts back to its starting-point in the morning. The most interesting point in the diurnal curve of the barometer is the occurrence of the morning maximum at noon, being the time when this phase of the pressure occurs at places situated close to the sea-shore. The maximum temperature occurs as early as from noon to 1 P.M.

MRS. GRIESBACH has presented to the Lord President of the Council, for the proposed scientific museum, a valuable collection of acoustical apparatus, invented and made by her late husband, John Henry Griesbach. This apparatus is now exhibited in the Loan Collection of Scientific Apparatus.

IN a supplement to the *Gardener's Chronicle* for Aug. 5, is given a well-illustrated description of the Royal Botanic Gardens at Kew, including views in the centre of the palm-stove, the succulent house, the temperate house, &c.

THE additions to the Zoological Society's Gardens during the past week include a Racoon-like Dog (*Nyctereutes procyonides*) from Eastern Asia, presented by Capt. W. H. Bingoym; seven Common Guillemots (*Uria troile*) and a Kittiwake Gull (*Rissa tridactyla*), British, presented by Sir H. Dalrymple, Bart.; a Brown Coati (*Nasua nasica*) from South America, presented by Mr. R. C. Corfield; two Hairy Armadillos (*Dasypus villosus*), born in the Gardens.

SCIENTIFIC SERIALS

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, April.—This number contains an article by Signor Denza, director of the Observatory at Moncalieri, on an inspection by him of observatories of the second order, according to the recommendations of the Leipzig and Vienna Conferences, for the correction of barometers. He has found that a safe verification can only be made when all the rules and precautions are observed, and recommends that the barometer taken in travelling from place to place should not be too narrow in bore, and should be carefully compared with the standard before and after the journey.—The next article is by Dr. Hann, on the results of observations made by the Swedish Arctic Expedition of 1872 in Spitzbergen and East Greenland, published in Stockholm. The observations are of great value, and deserve the full notice here given them by Dr. Hann.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. Vol. IX. Nos. 1, 2, 3 (1876). Among the papers contained in these numbers we note the following:—Singular structure of the leaves in the Empetroceæ, by M. Gibelli.—Sketch of Dr. Cantor's recent studies on the history of land-surveying, by M. Schiaparelli. -Researches on the action of oxygen, at the ordinary temperature on sulphur, on alkaline and terralkaline sulphides, and on hyposulphite of calcium, by M. Pellogio.—Report on the vine-disease of Phylloxera, by a Committee of the Institute. - On a new disease of chestnuts, by M. Gibelli.—On the constitution of veratric acid and veratrol, by M. Korner.—On the temperature of flames, by M. Ferrini.

Gazzetta Chimica Italiana, anno vi., 1876, fasc. iv.—E. Paternò and G. Briosi contribute a paper on hesperidin. These two investigators studied hesperidin derived from the common orange (*Citrus aurantium*, Risso). About 4,000 ripe oranges were found to yield 180 grammes of impure hesperidin. They experienced much difficulty in their endeavours to purify this substance.—G. Pisati contributes the only two original papers in addition to the one we have already noticed. His first paper details some experimental researches made by the author on electro-static induction. The second treats of the elasticity of metals at different temperatures.—The remainder of this number is filled up by summaries of the contents of foreign chemical journals, and a review of a book by T. Schutzenberger, "On Fermentation."

In the *Zeitschrift für Wissenschaftliche Zoologie*, vol. xxvi., part 2 (December, 1875), W. Repiachoff continues his contributions on the Chilostomous Bryozoa, giving many interesting particulars about the development of the amphiblastic ovum of Lepralia and Tendra. - Ludwig Graff describes the anatomy of the Sipunculoid *Chætoderma nitidulum*.—Dr. Hubert Ludwig writes on the interesting Gastrotrichous Rotifers, established as a separate order by Metschnikoff.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 18—"The Calculus of Chemical Operations.—Part II. On the Analysis of Chemical Events," by Sir B. C. Brodie, Bart., F.R.S., late Professor of Chemistry in the University of Oxford.

Introduction.—An account is here given of the origin of our views of the constitution of ponderable matter, regarded as constituted of units compounded of "simple weights." These considerations lead to two systems, and two only, in which the unit of hydrogen is respectively expressed by the symbols α and α^2. Between the systems we have no absolute means of selection, but a preference is here given to the system α as immediately leading to the law of even numbers.

The exception presented by the binoxide of nitrogen is then considered, and a hypothesis suggested to account for this anomaly.

The object of the work is then defined—namely, given a chemical event, how are we to determine the events of which it is compounded?

Section I.—The *Question of the Multiplication and Division of Chemical Equations* is here considered. It is shown that we may multiply and divide a chemical equation of the form $u = 0$, by any chemical function, if the sum of the numerical coefficients in that equation is equal to zero, but otherwise not. A method is given by which every chemical equation may be brought under this form. Such an equation is termed a "normal" chemical equation, for it is an equation on which we may operate by the rules of elementary algebra.

It is then shown that every chemical expression of the form $A(x-a)y-b$, and also $A(x-a)(y-b)(z-c)\ldots$ (that is, the continued product of any number of such factors more than one), necessarily $= 0$.

As regards the interpretation of normal chemical equations. Normal equations express the identity of the two members of the equation, not only as regards matter, but as regards matter and space also. Thus the equation $1 + 2\alpha\xi = 2\alpha + \xi^2$ asserts not only that the matter of two units of water is identical with the matter of two units of hydrogen and a unit of oxygen, but also that an empty unit of space and the space occupied by two units of water are identical with the space occupied by two units of hydrogen and a unit of oxygen.

It is further shown that in any chemical equation any one of the prime factors of the equation may be substituted for another, and the equation will still be true.

Section II.—Our knowledge of the identity of matter is derived from chemical transmutations or events; and every chemical equation may be regarded as the record of such an event or some number of such events. Chemical events may be regarded as compound or simple. A compound event is defined as an event which is regarded in the system of events under our consideration as constituted of two or more events. A simple event is an event which is not so regarded. Thus, for example, take the system of the four events:—

$$\begin{aligned}
&(1) \quad \alpha^2 v + \alpha^3\kappa^2\omega = \alpha\omega + \alpha^4\kappa^2 v,\\
&(2) \quad \alpha^4\kappa^2 v + \alpha^3\kappa^2\omega = \alpha\omega + \alpha^6\kappa^4 v,\\
&(3) \quad \alpha^6\kappa^4 v + \alpha^3\kappa^2\omega = \alpha\omega + \alpha^8\kappa^4 v,\\
&(4) \quad \alpha^2 v + 3\alpha^3\kappa^2\omega = 3\alpha\omega + \alpha^8\kappa^6 v.
\end{aligned}$$

The event 4 is a compound event, being the aggregate of the events 1, 2, 3; whereas the events 1, 2, 3 are in that system simple events, being incapable of such a construction.

Section III.—*On the Causes of Events.*—The cause of an event is given when the operations are defined by the agency of which the event occurs. *Def.* If in any chemical event the change in the arrangement of the symbols, by which the composition of the units of matter before and after the event respectively is symbolised, be of such a nature that where in the arrangement before the event the symbol x appears, the symbol a appears after the event, and where a appears before x appears after, so that the two arrangements differ in this respect and this respect alone, then the event occurs by the substitution of a for x, which is the "cause" of the event. Hence the same event may arise from more than one cause. Thus, for example, the event

$$Ayx + Aab = Aya + Axb$$

occurs by the substitution of a for x and of b for y, for these symbols satisfy the condition given in the above definition.

It is similarly shown that the event

$$Axyz + Aabz + Aayc + Axbc = Axyc + Aabc + Aayz + Axbz$$

occurs by the substitution of a for x, b for y, z for c; and, further, that if the equation to any chemical event be of the form $A(x-a)(y-b)(z-c)(v-d)(w-e)\ldots = 0$, that event occurs by the substitutions of a for x, b for y, c for z, d for v, e for w ....

If in these substitutions any symbol, say "a" $= 1$, the event occurs by the transference of the simple weight thus symbolised.

The following event occurs in three ways by the substitution of ξ for χ, the hydride of propyl, $\alpha^4\kappa^3$, being constant,

$$\alpha^4\kappa^3\chi^3 + 3\alpha^4\kappa^3\xi^2\chi = \alpha^4\kappa^3\xi^3 + 3\alpha^4\kappa^3\xi\chi^2,$$

the equation being of the form

$$\alpha^4\kappa^3(\chi-\xi)^3 = 0.$$

Similarly the event

$$\alpha^2\kappa\chi^3 + 3\alpha^2\kappa\chi = 3\alpha^2\kappa\chi^2 + \alpha^2\kappa$$

is an event occurring in three ways by the transference of χ, the equation being of the form

$$\alpha^2\kappa(\chi-1)^3 = 0.$$

I submit the following equation to the consideration of the reader:—

$$\alpha^4\kappa^3\xi(\beta-\xi)(\alpha\kappa^2\xi-1) = 0.$$

Section IV. *Elementary Analysis of Events.*—If the equation to a chemical event be capable of expression as the continued

product of rational factors of the form previously given ($x \; a$), x and a being prime factors of the equation, the event is a simple event incapable of further resolution; but occasionally the equations to events may be expressed by rational factors, although not of this form In this case they admit of an easy analysis into other events of which they are the aggregates Take, for example, the equation

$$a\chi^2 \;\; 2a\omega \quad 2a\chi + a\omega^2,$$

which may be written thus,

$$a(\chi \;\; 1)(\chi \;\; \omega) + a(\omega \;\; 1)(\chi \;\; \omega) \quad 0,$$

whence

$$a(\chi \;\; 1)(\chi \;\; \omega) \quad 0,$$
$$a(\omega \;\; 1)(\chi \;\; \omega) \; - \; 0$$

the constituents being

$$a\chi + a\omega \quad a\chi \;\; a\omega\chi,$$
$$a\omega\chi + a\omega \quad a\omega \;\; a\chi,$$

Again, the following event is the action of chlorosulphuric acid upon water

$$a\theta\xi\chi + 2a\xi \quad a\theta\xi^4 \;\; 2a\chi$$

This equation is of the form

$$a(\theta\xi \;\; \theta\xi \;\; 2)(\chi \;\; \xi),$$

whence

$$a(\theta\xi \;\; 1)(\chi \;\; \xi) + a(\theta\xi^2 \;\; 1)(\chi \;\; \xi),$$

the constituents being

$$a\theta\xi\chi + a\xi \quad a\theta\xi\chi + a\chi,$$
$$a\theta\xi^3\chi + a\xi \quad a\theta\xi^1 + a\chi,$$

The analysis of these two phenomena here indicated has actually been effected by experiment

Section V — In this section the doctrine of *Chemical Congruity* is discussed two chemical functions being said to be congruous to one another in reference to a special substitution if they assume the same value when that substitution is respectively effected in them

Further, a method is given for the *Development of Chemical Functions*, and for the complete theoretical analysis of any chemical event whatsoever—the theoretical analysis of a chemical event occurring by any number of specified substitutions, namely of a for 1, b for 1, c for , , being here said to be effected when all the different chemical events occurring in any way whatever by these substitutions are enumerated, the aggregate of which constitutes the event in question

PARIS

Academy of Sciences, July 31 — Vice Admiral Paris in the chair — The following papers were read On the capillary theory according to the Lorsey (first part Mentzchn), by M Trecul —Oscillations of temperature of half May, half June, and half July, 1876, non synchronic parallelism of the barometric pressure and the temperature, by M Sainte-Claire Deville A minimum of temperature on the 10th, 11th, and 12th respectively, and maxima, on either hand, about the 7th and the 16th — Fifth note on electrical transmission through the ground, by M du Moncel The conductivity of hard stones, as also, doubtless, that of the ground, with regard to plates buried in it, is far from being uniform throughout their mass. The metals used as electrodes with his silex may be ranked thus as to electromotive force, each being electro-negative to those which follow—platina, copper, brass, iron, tin, lead, zinc - Researches on the development of the chestnut, by M Baillon These throw some light on the disputed point of development of the cupule in the acorn —On the disease called diarrhœa of Cochin China, by M Normand It has wrought great havoc among the troops there It is caused by a parasitical worm in the tissues of the intestine Milk has been the best remedy hitherto —On the general theory of regulators, by M Wischnegradski.—On globular lightning, by M Hinte He describes a case of it at Paris, July 24 He thinks it due to spherical aggregation of air and steam through suction and rarefaction by the electric fluid, and condensation of positive electricity in this envelope of rarefied matter —Radiometer with vanes formed of a metal and of unblackened mica, by MM Alvergniat Frères. On heating and exhausting to a certain point, it became very little sensitive to light, would only turn with sunlight, but it had great sensibility to obscure heat —Observations on vines having galls in large quantities, by M. Lahman.—New confirmation of phylloxerian migrations, by M. Lichtenstein Nebulæ discovered and observed at Marseilles Observatory, by M. Stephan, Twenty three are described —Note on dissociation of the vapour of calomel, by M. Debray. Calomel undergoes a commencement of decomposition at 440. He heated it in a platinum tube, and held in the vapour a U-tube of gilt silver, through which circulated cold water There was a greyish deposit containing a little mercury so divided in a fine powder of calomel that it could not attack the gold On the laws of compressibility and the coefficients of dilatation of some vapours —Action of hydracids on tellurous acid, by M Ditte —On new salts of bismuth and their use in testing for potash, by M. Carnot. These are distinguished by their complete solubility in water They are double hyposulphites of bismuth and of alkalies On the isomery of rotatory power in the camphols, by M de Montgolfier —On a case of spontaneous alteration of anhydrous hydrocyanic acid, and a new case of total transformation of this acid, by M de Girard — On the decomposition of cyanide of potassium cyanide of zinc, and formiate of potash into carbonic acid, air, and pure hydrogen, by MM Naudin and Montholon On two new sulphuretted ethers, by MM de Clermont and Wehrlin —On the industrial employment of vanadium in manufacture of aniline black, by M Witz This proves a simpler and more economical mode of preparation —On the manufacture of dynamite, by M Sobrero He recommends moulding the siliceous matter, after moistening with water, into blocks, then drying, then dipping slowly in the liquid He experimented thus with fossil meal of Santa Fiora and olive oil, and was convinced that dynamite with 75 per cent of explosive matter could be made by this method, danger from friction is avoided On the agronomic map of the Arrondissement of Rethel (Ardennes), by MM Meugy and Nivoit —On fermentation of fruit placed in carbonic acid, by MM Joubert and Chamberland —Cellulosic fermentation by means of vegetable organs, and probable utilisation of the sugar in the vegetation for the formation of cellulose, by M Durin On the micro zymes of germinated barley and sweet almonds as producers of diastase and synaptase (*apropos* of note by MM Pasteur and Joubert), by M Béchamp —Rectification of a former note on a product in the United States, and the property of hops as ferment, by M Sace —On the fermentation of urine, by ... (of a communication of M Pasteur, by Dr Bastian ... only when used in a proportion corresponding to the acidity and quantity of the liquid ... M Pasteur has direct proof that germs of Bacteria can survive in a liquid as caustic as the solution of potash made in the pharmaceutical proportions, when it is raised even for only a few instants, to 100 Observations on opinions attributed by Prof Bastian to Prof Tyndall, *apropos* of the doctrine of spontaneous generation extracts from two letters from Prof Tyndall He expresses surprise at being cited as guaranteeing the exactness of Dr Bastian's experiments, and his entire concurrence with M Pasteur —On metallic powders in the atmosphere, by M Tholozan

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THURSDAY, AUGUST 17, 1876

A PHYSICAL SCIENCE MUSEUM

MANY of our readers will, no doubt, entertain the belief that the proposal to establish a Museum of Pure and Applied Science, to include what is known as the Patent Museum, recently laid before the Duke of Richmond and Gordon by the President of the Royal Society and other distinguished men of science, has been a thing of sudden growth. Some justification for such a belief may seem to be derived from the Loan Collection of Scientific Apparatus now being exhibited at South Kensington, and many of those who have witnessed its success would like to see it developed into a permanent institution. No doubt, this Collection has helped to bring into practical shape the desire which for years many men of science in this country have possessed of seeing this country possessed of an institution similar to the Paris Conservatoire des Arts et Métiers, which desire has at last taken the form of the all but unanimous memorial on the subject which was recently presented to the Lord-President of the Council, and which we published in a recent number. But the truth is that this memorial is strictly in accordance with an official recommendation made to the Earl of Granville, then Lord-President of the Council, as far back as the year 1865. At that time the Secretary of the Science and Art Department and Director of the South Kensington Museum, Mr. (now Sir) Henry Cole, along with the late Capt. Fowke, were instructed by the Lord-President to proceed to Paris and report upon the relations between the Conservatoire des Arts et Métiers and the French Patent system.

The results of this official visit to Paris were given in a report by Mr. Cole and Capt. Fowke to the Lord-President, which will be found in the "Twelfth Report of the Science and Art Department" (1865), and was laid before Parliament. As few of our readers can have access to this Report, and as those with whom the decision as to the memorial will rest, cannot be expected to know all that has been previously said and done in this matter, and as, moreover, the subject is one of prime importance to the country and to science, we believe we shall be doing good service by exhuming from this old blue-book the special Report to which we refer :—

REPORT ON THE CONSERVATOIRE DES ARTS ET MÉTIERS AND BREVETS D'INVENTION.

TO THE LORD PRESIDENT OF THE COUNCIL.

South Kensington Museum, January 1865.

MY LORD,—In obedience to your Lordship's instructions that we should proceed to Paris and examine into the relations which exist between the *Conservatoire des Arts et Métiers* and system of French patents, we have prepared and have now the honour of submitting, the following report.

1. The *Conservatoire* of late years, under the able direction of General Morin and M. Tresca, has become one of the most popular institutions in Paris.

2. This establishment, first created in 1788, has passed through many phases of constitution and management. At the present time it has three predominant features: (*a*), the public exhibition of machinery, manufactures, and models of an industrial and scientific nature; (*b*), a scientific library open gratuitously to all; and (*c*), courses of gratuitous lectures given during the autumn and winter in the evening by the most eminent professors in France. These lectures are attended by several hundred persons. A prospectus of the courses for the present session is appended (p. 280).

3. Besides these three features, the *Conservatoire* is the repository for the *Brevets d'Invention* and the models deposited with them, which have exceeded the age of 15 years from the first issue of them. This connection of the institution with extinct *Brevets d'Invention* is a subordinate feature to its chief operations.

4. The *Conservatoire* consists of a series of ancient and modern buildings. The ancient, belonging to the abbey of St. Martin des Champs, date from A.D. 1060, and are highly interesting to the archæologist. They have been well adapted to the purposes of the establishment, especially the old refectory, now converted into the library.

5. The principal façade is now opened to the new *Boulevard de Sevastopol*, fronting a large square. Additional parts of the old monastic buildings of the convent of St. Martin are being restored and brought into use, whilst new buildings are being constructed to afford additional space. The ground already occupied by the establishment is 5·178 acres (or 20,956 mètres carrés), and this is being extended to 6·558 acres, or 26,540 mètres carrés de terrain. The buildings themselves occupy at present 8,383 mètres carrés, or 10,026·346 square yards, which will be enlarged to 16,741·565 square yards.

6. The laying out of the ground and the divisions into which the collection is arranged are shown by the accompanying plan (App. C).

7. The divisions are—machinery in motion, hydraulics in motion, agricultural implements, locomotives, horology, building models, &c.

8. These plans show the position of the two chambers, the lower of which contains the specifications of *Brevets d'Invention*, whilst the upper contains the models. These chambers are on the opposite side of the court to the library, and have no connection with it. These rooms are about 60 feet long by 20 feet wide. The contents are very miscellaneous, and covered with dust, such as old hats, and woven fabrics, traps, tin ware, surgical appliances, and broken wooden models. It is not surprising that they are not considered of sufficient value or public interest to be kept with the general collection. They are never consulted. M. Tresca, the sous-directeur, has kindly answered some questions which we put to him (see p. 287). He shows that they do not influence the extent of the general collection of machinery, &c., and their value to it is explained to be nothing.

9. On Thursdays and Sundays the galleries are open free, and are crowded. On other days, reserved for students, the principle of admitting the public by a moderate charge, as at South Kensington, has been adopted, and visitors pay one franc each.

10. Four separate authorities throughout France are concerned in the issues and searches of *Brevets d'Invention*.

a. The Ministry of Finance.
b. The Ministry of Agriculture and Commerce.
c. The Prefecture of the Department.
d. The *Conservatoire*.

The necessary instructions, &c., for obtaining a brevet are given in a paper appended (page 282). It will be observed that the instructions make no mention of models as any part of a *Brevet d'Invention*, and, as M. Tresca shows, they are of no value whatever.

11. In Paris all *Brevets d'Invention* are kept and registered. Those under 15 years of age are preserved in the *Rue de Varennes*, on the south side of the Seine; those above that age in the *Conservatoire des Arts et Métiers* on the north side, about two miles apart.

12. The steps necessary to be taken in Paris for ob-

taining a *Brevet d'Invention* are as follows :—The applicant for a patent must first apply to No. 24, *Rue de Mont Thabor*. This is a subordinate bureau of the Ministère des Finances, not very readily found or publicly indicated. He passes through a gateway between the *Café des Finances* and a stable for *remises*. He ascends to the second stage up narrow stairs, dark and odorous. Here is the bureau for the first stage of proceeding. He pays 5 francs, and obtains the necessary forms to be filled up; fills them up and pays 100 francs.

13. These forms being filled up, he takes them with the receipt to the *Hôtel de Ville*, and there he deposits his specification.

14. This specification is sent to a third bureau, which is on the opposite side of the Seine, No. 78, *Rue de Varenne*, the Ministère de l'Agriculture et du Commerce, and is also up two pairs of narrow dark stairs. Here the specifications are kept during 15 years, whilst the patent lasts; after that period they are transferred with any models accidentally accompanying them to the *Conservatoire des Arts et Métiers*. The room for searches is about 60 feet long and 16 feet wide. The specifications are arranged in *carton* boxes on shelves. It is rather crowded. Anyone enters and searches in the printed catalogues and calls for the *brevet* without let or hindrance; but he is not permitted to make notes even in pencil. Copies must be ordered of the office at a given tariff, and if a copy of a drawing is required, he must bring his own draughtsman.

15. The catalogue of the specifications is printed, and may be bought at V. Bouchard Huzard, Rue d'Eperon, No. 5.

16. It has been already pointed out that the law does not require that any models should be made, but some are sent. The officers kindly showed us what they possessed. We were conducted up back stairs into a little room about 10 feet wide by 20 feet long. The floor was covered with nodels unarranged, and very dusty. On a shelf were ome models in tin, also very dusty. A model of a shoe vas here, a candlestick there, &c. The officer said that hey were very rarely looked at, and the accuracy of the tatement was fully borne out by the condition of the oom. He said that all the models in this small chamber vere the products of some 20 years.

17. These facts show that the *Conservatoire des Arts t Métiers* did not arise and is not at all dependent on ny connection with models accidentally delivered with he *Brevets d'Invention*, which are not recognised by the 'rench law. The *Conservatoire* is a great educational istitution, teaching the general public through its exhiitions, and a special public through its lectures. It seems o us to afford an example which our own country might nitate with advantage generally as to scope and also in iany of its details.—We have, &c.

(Signed) HENRY COLE,
FRANCIS FOWKE, Capt. R.E.

A map accompanies this Report which shows the buildngs then occupied by the Conservatoire and those which . was proposed to build in addition. If the Commisioners of the 1851 Exhibition, to whose laudable scheme e recently referred, have not already consulted this map nd the Report, we think they might do so with great dvantage. There are many points in common between ne scheme which they are considering and the plan which as then being carried out by the French Government, nd which resulted in an institution that has been in workng order for years, with, it is universally acknowledged, he best results to science and to France.

In the same Appendix M. Tresca furnishes answers to number of questions with reference to the actual use nade of the models of patents in the Patent Museum of Paris. The information thus afforded we would recommend to the notice of the Treasury Commission which has for some time been cogitating as to what course to pursue with regard to our own Patent Museum. The analogy between the two cases is very complete, and it suggests that the best solution lies in a course similar to that which has been followed in France. From M. Tresca's answers we learn that in the Catalogue of Patents there were 7,300 entries of models, only 10 of which are accompanied by specifications. While 1,400 specifications had been consulted during 1864, not a single model had been examined or asked for, thus showing that the models were a practically useless part of the Patent Museum. M. Tresca states that the place of a model can be supplied by a drawing, leading to more complete, exact, and certain results, and thus avoiding useless expense. Their loss, therefore, would really be a gain to the Conservatoire; they cause, M. Tresca states, embarrassment by their compulsory preservation, the objects rarely representing the final idea of the inventor. They for the most part get destroyed by time without having been consulted by any one. Might not a somewhat similar report be made of our own Collection of "Patents"?

The same blue-book contains some valuable information with regard to the lectures which were then given in the Paris Conservatoire, which is worth consulting. Later and more complete information in this department may, however, be found in the appendix to the Report of the Duke of Devonshire's Commission. From what we have said, it will be seen that the idea of a Government Science Museum is by no means of recent growth, but that, on the contrary, it has taken many years to come to a practical issue; and that, moreover, we have a ready-made example which has stood the test of years, and is now doing work of the highest practical value in the Paris Conservatoire des Arts et Métiers.

COHN ON THE BIOLOGY OF PLANTS

Beiträge zur Biologie der Pflanzen. Herausgegeben von Dr. Ferdinand Cohn. (Breslau, 1875.) Drittes Heft.

THE third part of Cohn's "Beiträge," now before us, completes the first volume, and let us express the hope that we may have another volume before very long. Curiously, each of the three parts has been separately paged, an arrangement which renders it necessary to note the part as well as the page when the index is consulted. If we may judge from the size and price, each part has increased in importance, so that the third part has more papers and is nearly double the size of the first. In all the parts there have been papers of great interest and value, and those in the present part are in no way behind their predecessors. Dr. Cohn himself contributes three papers to the present part, Dr. J. Schrœter two, while Drs. L. Just, A. B. Frank, Richard Sadebeck, and Eduard Eidam, each one. The first paper is by Dr. Schrœter on the Development of certain Rust-Fungi. On *Carex hirta*, one of the Uredineæ was observed which Dr. Schrœter believes to be *Puccinia caricis* of De Candolle; and as he had reason to suspect that *Æcidium urticæ* of Schum was only a stage in the life history of *P. caricis*, experiments were made to ascertain definitely whether *P. caricis* was heterœcious, and if so, whether *Æcidium*

urticæ was one of the stages. Details of the experiments are given, and Schrœter concludes that *Æcidium urticæ* is a stage of *Puccinia caricis*. In a note to his paper, Dr. Schrœter mentions that Dr. Magnus, of Berlin, has made similar experiments with the same result, an important confirmation of the remarkable habit these curious plants have of changing from one host to another, and at the same time changing the form of their spores, a condition described by De Bary long ago in the rust of wheat. A second form noticed by our author is a species of rust common on many grasses. It has many names, and Dr. Schrœter calls it *Uromyces dactylidis*, Ottli, (*Uromyces graminis*, Cooke). One stage is spent in our common grasses, such as *Dactylis glomerata*, *Poa nemoralis*, *P. trivialis*, *P. annua*, *P. pratensis*, &c. The other stage occurs on *Ranunculus bulbosus*, *R. repens*, and *R. polyanthemos*, and is known as *Æcidium Ranunculacearum*, D.C. The Æcidia occurring in other Ranunculaceæ (*Clematis*, *Thalictrum*, &c.) seem to belong to other species. Dr. L. Just's paper is a physiological one, showing the effect of the epidermis of the apple in preventing loss of water by transpiration. The third paper, by Dr. J. Schrœter, on the effect of disinfectants in lower organisms, shows markedly the value of carbolic acid in destroying germs. In the fourth paper Dr. A. B. Frank shows how light influences the relative time of development of the flowers in a catkin, those flowers opening first which receive the most light. Next follow two papers by Dr. Ferdinand Cohn, one on the "Function of the Bladders of Aldrovanda and Utricularia," the other on the "Development of the genus Volvox." English readers are already acquainted with the more important facts recorded in the first paper, as they have already been made use of by Mr. Darwin in his work on "Insectivorous Plants." The second paper is of especial interest in relation to the re-distribution of the Thallophytes, by Prof. Sachs, in the fourth edition of his justly celebrated "Lehrbuch." The structure of volvox is carefully described, and its modes of reproduction both sexual and non-sexual. The non-sexual reproductive cells Cohn calls Parthenogonidia. Non-sexual reproduction seems to take place during the whole year, and the alternation of generations is completed by the occurrence of sexual reproduction in the spring. The volvox-colony, or cœnobium, is either monœcious or diœcious, the female cells, or Gynogonidia are either produced along with the male cells, or Androgonidia, in the same colony, or they are not. Cohn proposes to divide the Linnæan Volvox globator into two sub-species, namely, (*a*) *Volvox monoicus*, and (*b*) *Volvox dioicus*, the former having both andro- and gynogonidia, the latter either one or other. The structure of Volvox is very like that of Pandorina, but the reproduction is like that of Sphaeroplea, and it belongs, not to the Zygosporeæ, which have conjugating zoospores, but to the Oosporeæ. Cohn, however, does not consider the Zygosporeæ and Oosporeæ to be separate classes of the Thallophyta, but only to be subdivisions of one class, to which he gives the name of Gamosporeæ. The next division Cohn calls the Gamocarpeæ, a division quite equivalent to Sachs' Carposporeæ. In the Gamocarpeæ there are two methods of fertilisation. One by means of the Pollinodium, analogous to the conjugation in the Gamosporeæ, the other by Spermatia, resembling the Spermatozoids. In the higher plants a somewhat similar arrangement exists; the Muscineæ and Vascular Cryptogams having Spermatozoids, while the flowering plants have pollen and pollen-tubes, showing a certain analogy to the pollinodium of some of the Carposporeæ.

Dr. Richard Sadebeck contributes a paper on the remarkable parasite living in the cells of the prothallium of Equisetum, and called *Pythium equiseti*. It belongs to the Oosporeæ, and its structure and life-history is here well described.

The part concludes with two papers, "Researches on Bacteria," Parts II. and III. The first is by Dr. Cohn, and is a continuation of his paper with the same title in the second part of the "Beiträge," while the other is by Dr. Eduard Eidam. In the latter paper Dr. Eidam gives details of a series of very interesting researches on the action of different degrees of temperature and of drying on Bacterian Termo. The Bacteria were cultivated in Prof. Cohn's normal nutrient fluid, and the solution kept at definite temperatures for definite periods of time. The activity of Bacteria does not begin until the temperature rises above + 5° C. + 5½°, being the temperature at which they begin to multiply, although very slowly. Between 30° and 35° C. the multiplication is most rapid, but at 40° the activity again diminishes, and the Bacteria in the nutrient fluid are killed by exposure for fourteen hours to a temperature of 45° C., or for three hours at a temperature of 50° C. When dried the Bacteria can retain their vitality for a long time at high as well as at low temperatures. All these experiments are of especial interest at the present time and seem to have been conducted with great care. Prof. Cohn's paper deals chiefly with descriptions of new or imperfectly known genera and species, and concludes with an attempt at grouping the different genera of Bacteriaceæ according to their natural affinities. The close relation of Bacteria to the Phycochromaceæ is pointed out, and it is shown to be impossible to erect the Bacteriaceæ into a family separate from the Phycochromaceæ. Naegelis' name of Schizomycetes is objected to on the ground that Bacteria are not fungi, and the term Schizophyta proposed for the group instead. This group is nearly equivalent to and would take the place of Sachs' first class of Thallophyta, namely, the Protophyta. The Schizophyta includes two tribes: (1) Glœogenæ, in which the cells are either free or united by gelatinous substance; and (2) Nematogenæ, which are filamentous. To the first tribe belong such genera as Chroococcus, Micrococcus, Bacterium, Aphanocapsa, Glœocapsa, Clathrocystis, Sarcina, Polycystis, &c.; while to tribe 2 belong Beggiatoa, Oscillaria, Vibrio, Spirulina, Anabæna, Nostoc, Rivularia, Cladothrix, Scytonema, &c. The paper is an exceedingly interesting one, and has most important bearings on the classification of the Thallophytes.

W. R. McNab

FERNET'S PHYSICS

Cours de Physique. Par É. Fernet. (Paris: G. Masson, Editeur, 1876.)

FROM the great success which attended the publication of Prof. Ganot's "Éléments de Physique," due in a great measure to the excellence of its illustrations, and followed as it was a few years later by the splendidly got up "Traité" of M. Deschanel, which has been so ably

translated into English by Prof. Everett, there has been an almost continuous stream of works upon Physics from our neighbours across the Channel. French publishers of technical works appear to be of opinion that the production of a "Traité de Physique" is an indispensable part of their duty, and that their good name will suffer unless they bring one out. France is fortunately rich in physicists, so that there are always good men to be found to do the work. The result is that each Paris season introduces one or more new books upon Physics, which are in most cases well written, and generally abound with excellent illustrations.

The "Cours de Physique" of Prof. Fernet is at once both ably written and singularly incomplete. It is intended as a text-book for the *Classe de Mathématiques Spéciales*, and as such cannot altogether be classed with the books of which we have been speaking. It is written for a special purpose, and its value to the general student is much impaired thereby.

The chapters treating of the molecular construction and of the various forms of matter is a concise digest of the modern theories of this most speculative subject, and the definitions of the solid liquid and gaseous states of matter are particularly clear. On the other hand, no reference whatever is made to the all-important subject of gravitation, so that the laws of falling bodies and projectiles, centre of gravity, and even the pendulum itself, are necessarily cut out.

Again, hydrostatics is both fully and ably treated, the law of Archimedes and the determination of specific gravities being very clearly explained.

The whole subject of heat is confined to the expansion under its influence of solid, liquid, and gaseous bodies, which occupies one-fourth of the whole book. The reader looks in vain for some reference to the laws of freezing and evaporation or of conduction and specific heat. More extraordinary still is that the entire subject of radiant heat is conspicuous by its absence, no reference being made to diathermancy or to the reflection and refraction of heat, and the dynamical theory is ignored altogether.

In Optics the laws of reflection and refraction are more fully treated than any other subject in the book, the properties of mirrors and lenses of various forms being thoroughly and mathematically considered. No reference is, however, made to dispersion, and the question of colour is left out altogether, necessitating of course the omission of the important subject of spectra and of the Fraunhofer lines. Again, double refraction and all the phenomena connected with polarisation are not even alluded to, nor are the interesting subject of the velocity of light and the beautiful experiments of Foucault, of Fizeau, and of Cornu for its determination.

Acoustics is entirely left out, and statical electricity occupies but a short chapter, in which induction is fairly treated, and the various forms of electrical machines are well described.

What is perhaps the most remarkable omission of all is that of the entire subject of Electro-dynamics. No mention is made of the voltaic battery, of the great subject of electro-magnetism and the electric telegraph, of electrolysis or of induced currents as exemplified in the Ruhmkorff coil, neither are magneto-electricity or thermo-electricity referred to.

The only explanation offered for the omission of so important a branch of physical science in a "Cours de Physique" is the following foot-note to the chapter upon Statical Electricity :—

"By the rules for admission into the *École polytechnique*—which are identical with those for the *Classe de Mathématiques Spéciales*—candidates are required to possess an elementary knowledge of statical electricity and of magnetism only. The importance, therefore, of these two subjects in the present course does not admit of their being treated as fully as those in the preceding chapters. The further study of them must be reserved for the course in the *École*, where students are required to work up the subjects of both dynamic electricity and electro-magnetism."

We may assume from this note that the other omissions to which we have referred are due to the same regulations. It is difficult to understand how such rules can exist, or what considerations could have guided those who framed them when they required candidates for admission to read up statical electricity, leaving the more important subject of electro-dynamics alone, as well as the science of electro-magnetism, notwithstanding its important applications.

From what has been said it will be seen that Prof. Fernet's "Cours de Physique" is evidently a "cramming" book for students seeking admission to a particular class which has very exceptional requirements. For that purpose it is no doubt of value, but it is practically unavailable to the general student of Physics by reason of the number and the importance of its omissions.

THE CHEMISTRY OF LIGHT AND PHOTOGRAPHY

The Chemistry of Light and Photography in their Application to Art, Science, and Industry. By Dr. Hermann Vogel, Professor in the Royal Industrial Academy, Berlin. New and thoroughly revised edition, with 100 Illustrations. (London: H. S. King and Co, 1876.)

LAST year, in reviewing in the columns of NATURE this volume of the International Scientific Series, it became our duty to point out the very serious errors in chemistry with which the translation abounded.

We are happy to find that in this "new and thoroughly revised edition," the whole of the objectionable passages have been corrected, and that the same measure of correction has been extended to the English throughout, so that the work is now a very creditable translation. With regard to the author's share of the work, we can, on a re-perusal, recommend it as a thoroughly good *résumé* of the principal photographic processes, and we note that the very numerous variations of the photo-printing and lithographic processes have been very fully noted and their chief points described, for, although this description of what are, as a rule, trivial variations of one or two processes may seem useless, it cannot fail to call the reader's attention to some of the vagaries permitted by patent laws in various countries. We also notice that some considerable space has been given to astronomical photography (in connection with which we would note that the name of the eminent American astronomer who produced the negative of the moon from which the frontispiece of the book is taken is Rutherfurd, and not Rutherford, as

printed). Slight notices have also been given of spectrum-photography, which we hope to find fuller in a new edition, and of the effect of colouring matters in modifying the action of light on various reagents, the study of which latter point appears to be undergoing considerable development both at home and abroad.

Taken as a whole, the book is an admirable guide to one who has some considerable knowledge of the subject, or for giving the general points of the art to an ordinary reader, but we do not think that it is equal to Van Monckhoven's book as a practical treatise on the art. It abounds, however, in valuable hints and suggestions, and we would recommend Chapter XII., "On the Correctness of Photographs," to the attention of everyone who wishes to become a competent photographer, whether for the purposes of Science or of Art. With regard to the latter we cannot do better than conclude with the following quotation from the chapter in question, page 129:—

"It may, perhaps, excite surprise that the writer ascribes greater truth to painting than to photography, which is generally regarded as the truest of all methods of producing pictures. It must be self-evident that this remark can be made only of the works of masters . . . the picture of the photographer is not self-created. He must test, weigh, consider, and remove the difficulties which oppose the production of a true picture. If his picture is to be true he must take care that the characteristic is made prominent and the accessories subordinate. . . . To do this he must, of course, be able to detect what is characteristic and what accessory in his original. The sensitive plate of iodide of silver cannot do this; it receives the impression of all that it has before it, according to unchangeable laws. . . . The photographer will not, indeed, be able to control his matter like the painter, for the disinclination of models and optical and chemical difficulties often frustrate his best endeavours; hence there must always be a difference between photography and a work of art. This difference may be briefly summed up by saying that photography gives a more faithful picture of the form, and art a more faithful picture of the character."

R. J. FRISWELL

OUR BOOK SHELF

Les Insectes; Traité Élémentaire d'Entomologie, comprenant l'Histoire des Espèces utiles et de leurs Produits, des Espèces nuisibles et des Moyens de les détruire, l'Étude des Métamorphoses et des Mœurs, les Procédés de Chasse et de Conservation. Par Maurice Girard. (Paris: Baillière et Fils, 1873–76.)

As a compilation this work evidences a considerable amount of industry; judging, however, by the various memoirs quoted in the first 240 pages, it would appear that the author's researches have not extended to a much later date than the year 1868, a fact which will unquestionably detract very greatly from the value of his generalisations.

The author's object being to unite in one book the classification, geographical zoology, and economy of insects, he divides his introduction into the following heads:—1. Anatomy and Physiology; 2. Instinct and Intelligence; 3. Collecting and Preservation; 4. Palæontology; 5. Geographical distribution; 6. Species and Classification; the consideration of which subjects occupies 229 pages.

Owing to the bulk of the work (which, although up to the present time it has only dealt with three orders of insects, nevertheless extends to 840 pages), we cannot strongly recommend it as a pocket companion; still the student of entomology, particularly if he has a taste for preserved viands *warmed up*, should certainly find a place for it upon his library shelves.

The plates are clearly defined and abound in instructive details, the only drawback being that they are for the most part reproductions of the illustrations to Guérin's "Iconographie du Règne animal;" it is, however, satisfactory to note additional representations of an anatomical character, as also of certain highly interesting cave-inhabiting species.
A. G. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Protective Mimicry

In the last number of NATURE Mr. Murphy brings forward the following argument against natural selection, with reference to protective mimicry. He advances two classes of cases in which he urges the improbability of the occurrence of a first variation in the requisite direction. "One of these is the change of colour with the season of such animals as the ermine, which is brown in summer and white in winter. Had the ermine been either permanently brown or permanently white, there would have been nothing wonderful in it, but it seems impossible that the character of becoming white in the winter and brown in the summer could ever have originated in ordinary spontaneous variation, without a guiding intelligence."

Now Pallas as quoted by my father ("Descent of Man," second edition, p. 229 and 542) states that wolves, horses, and cattle, as well as *nine* other kinds of mammals become lighter coloured during the winter; and several well marked cases of a similar change of tint in the winter coat of horses in England have either been brought under my father's notice, or have been observed by himself. It is impossible to suppose that these instances of a similar change occurring in widely distinct animals can be put down as partial reversions to an ancestral habit of turning *completely* white during the winter months. We may therefore presume that they are due to the "direct action of the conditions of life;" we might perhaps compare them to the greyness accompanying the impaired nutrition of old age; or to that caused by injuries, *e.g.* in the hair about old sores on the withers of horses; or again to the extraordinary recorded case of temporary greyness of the eyebrow accompanying frontal neuralgia.

But to whatever cause these slight changes of colour in certain quadrupeds taking place at the beginning of winter are due, there can be no question that they supply the identical "first variations," whose occurrence Mr. Murphy thinks so "infinitely improbable." It is impossible to doubt that with such material to work on, a process of rigorous natural selection might develop almost any degree of seasonal change of fur. "The roe, for instance, has a red summer and a greyish white winter coat; and the latter may perhaps serve as a protection to the animal whilst wandering through the leafless thickets, sprinkled with snow and hoar-frost." If the roe "were gradually to extend its range into regions perpetually covered with snow, its pale winter coat would probably be rendered through natural selection, whiter and whiter, until it became as white as snow." ("Descent of Man," p. 542). Mr. Murphy also adduces the manner in which the chameleon, and certain fish, protect themselves by rapid changes of colour. He remarks that it seems "utterly impossible for such a character to originate in spontaneous variation." It would be taking up too much space to enter into this subject; it may, however, be worth noting that according to Pouchet, under certain conditions the changes of colour are only developed in the turbot in several days. Again J. Bedriega asserts that various parts of the body in certain lizards are *permanently* altered in tint by exposure to the sun; and he states that the mechanism by which this change is effected is precisely the same in principle, as that to which the variations in pigmentation are due in the chameleon. Brucke and others have shown that in the chameleon the changes of tint may be produced by agencies having no connection with protection; for example, by the excitements of anger and sexual passion, by illness, and by local irritants and nerve-stimulation.

An accurate observer related to me the case of a lady whose iris changed colour in bright sunlight.

These few instances seem to show that the behaviour and properties of pigment-cells are independent of the protective functions for which they have, in some cases, been specialised and augmented by the action of natural selection.

It seems a pity that Mr. Murphy should write on a question in natural history without making himself better acquainted with what is known on the subject. FRANCIS DARWIN

Down, Beckenham, Aug. 14

IN the last number of NATURE Mr. J. J. Murphy states the difficulty which he finds in accounting for the rise of intermittent variations upon the theory of natural selection. He can understand the origin of a white species from a brown one or *vice versâ*, but not of a species which, like the ermine, is at one season brown and at another season white. He speaks of "facts of colour which it seems impossible for natural selection to produce, from the infinite improbability of a first variation ever occurring." From this mode of expression one might fancy that Mr. Murphy had for the moment forgotten that natural selection is in no way concerned with producing, but acts only by preserving, variations. As in a great number of instances we are ignorant of the precise antecedents which produce variation, whether chronic or recurrent, in such instances, we must be left at liberty, if we choose, to invoke the special action of "a guiding intelligence." The case, however, of an animal which changes its colour with the season does not seem to be one of very exceptional difficulty. It is only necessary to suppose that the animal became possessed of pigments liable to be acted on in the required direction by the seasonal changes of light and heat. It might well be that with some animals the influence of the same changes would be in a direction just the opposite of what was useful to them. In that case the variety would stand but little chance of being preserved. Similar explanations hold with regard to the vegetable kingdom. I have now before me drawings of *Sempervivum spinosum*. The summer rosette is bright green in colour, with the leaves expanded, while the winter rosette is a compact little ball of a dull purple. Thus the plant prepares itself against the cold of winter and the dearth of nourishment which that season brings, but it is likely enough that cold and dearth in the first instance led to the variation in the plant from its summer habit.

In human beings the hair is said sometimes to turn white from sudden grief or terror. Liability to such a change does not probably carry any such advantage to the human species as would make it likely to spread and develop itself further. But in the little shrimp commonly known as *Mysis chamæleon*, we can at least conjecture that a very solid advantage might follow from a similar characteristic. I have sometimes bottled live specimens of this little creature while it was of a dark purple colour, and presently after lost sight of it, the fact proving to be upon closer inspection that it had become almost completely transparent. Among its ordinary enemies the loss of colour might often save its life, in which case natural selection would tend to preserve the aptitude, although the aptitude itself, like the bleaching of human hair from grief, has no connection at the outset with the advantage of the species.

Torquay, Aug. 14 THOMAS R. R. STEBBING

MR. MURPHY's letter (NATURE, vol. xiv. p. 309) opens up a wide field for speculation. The class of cases to which he directs attention constitutes what I have designated "*variable* protective colouring," and in a paper communicated to the Zoological Society (Proc. Zoo. Soc., 1872), I attempted to show that such cases came to a certain extent within the scope of natural selection. The line of argument pursued is briefly as follows:—Natural selection, working solely for the good of a species takes advantage of all beneficial variations, no matter how they may originate. In but very few cases can the cause of any particular variation be assigned. Natural selection works only on the variations presented to it, the causes of such variations appearing to us, in the absence of observational or experimental evidence, mysterious. If, then, a species deriving advantage from protective colouring under one set of conditions, finds that the conditions vary periodically or irregularly, thus rendering that mode of colouring useless or even disadvantageous, it clearly becomes advantageous to the species to possess a *power of adaptation*. By this means only can *varying* external conditions be met, and it is upon this *adaptive power* that I venture to think the action of natural selection has in these cases been exerted. That the particular cause of such variation cannot be assigned, no more weakens the natural selection argument in these cases than in ordinary instances of permanent protective colouring, the possibility of which having been brought about by the "survival of the fittest," Mr. Murphy seems disposed to admit.

One argument in favour of the natural selection theory of protective colouring appears, so far as I am aware, to have been overlooked. It has been urged that granting the power of natural selection to produce a general resemblance in colour, &c., to inanimate objects, it is difficult to see how the highly perfect finishing touches (instances of which are familiar to all naturalists) could have been imparted by this same agency. To this it may be replied that the marvellously perfect resemblances which we witness have not been brought about to deceive *our* visual sense, but that of far keener-sighted foes whose very means of subsistence may depend upon acuteness of vision.

Apropos of Mr. Power's letter in the same number of NATURE, I have recently had an opportunity of observing how closely the larva of *Trachea piniperda* resembles in the longitudinal green stripes the needle-shaped leaves of the pine on which it feeds. I observed also an equally good adaptation in a larva of *Agriopis aprilina*, which when resting on a lichen-covered oak trunk was barely discernible from the lichen on which it rested.

Belle Vue, Twickenham, Aug. 12 R. MELDOLA

Antedated Books

THE grievance pointed out by your correspondent "F.Z.S." is a real one. Nevertheless I trust that the writer is himself free from the charge that he so glibly brings against a brother naturalist of endeavouring to obtain for his generic titles an "unjust priority of fifteen months over what they are entitled to." I am sorry that there should be a Fellow of the Zoological Society who believes me capable of doing this, but, as the charge has been thus publicly made, I lose no time in flinging it back upon my anonymous accuser. The new edition of Layard's "Birds of South Africa" was announced to appear in six parts, and the first was published in May, 1875. The number of wrappers required for the six parts was printed off at the time, and "F.Z.S." will find that Part 2, which was published last autumn has precisely the same wrapper as Part 1, and this is the case with the part now issued. I admit that it would have been better to have altered the date on each wrapper in writing; but this, probably, did not occur to my publisher, who is doubtless not aware of the importance attached to the law of priority by "F.Z.S.," your correspondent, who, apparently, in his hurry to attribute an unworthy motive, has scarcely taken the trouble to look beyond the cover of the book. Had he done so he might have been satisfied that the letterpress contained abundant evidence of having been written long after the date which he would have the scientific world believe I had endeavoured to claim for its publication. Such an attempt would be absurd when documents are quoted in the letterpress which were *not in existence in the year* 1875.

May I at the same time reply to a paragraph of your reviewer (p. 318) on the "Birds of Kerguelen Island." This pamphlet deserves all the praise which the reviewer bestows on it, but in his endeavour to disparage his own countrymen, and to trumpet the superior energy of American ornithologists, he seems to have done an injustice to Mr. Eaton and myself. Two new species were mentioned by Dr. Coues, viz., *Æstrelata kidderi*, which Mr. Salvin (*Orn. Misc.*, p. 235) shows to be *Æ. brevirostris* (Less.), and secondly, *Querquedula eatoni* (Sharpe). This latter name looks as if the English ornithologists had not been so far behind their American brethren, after all, if the description of the new Teal was available for quotation in Dr. Coues' work! R. BOWDLER SHARPE

British Museum

FULLY agreeing with "F.Z.S." in reprobating the evil practice of which he complains, I think that in the particular instance he cites, of the recently published third part of the new edition of "The Birds of South Africa," he will, on looking again at its wrapper, see that the information it affords is so contradictory as to be worth nothing. The first words upon it are "To be completed in *Six Parts*:" but on its second page we read that the publisher "has decided upon issuing this work in *four* parts!" Which of these statements is to be believed? In justice to the publisher, however, it is to be observed that the number "3" is not printed, but inserted with the pen, in the

copy I have received, and also that the "May, 1875," has a line drawn through it. While on the subject let me add that the Zoological Society itself, in its "Transactions," sets a bad example in this respect. Each paper bears a date at the foot of its first page, but the date is likely to be misleading in years to come, for it is that of the *printing* off the sheet—an essentially private matter, with which the public has nothing to do—and not that of the *publication*.

Another F. Z. S.

Meteor Observations

A BRIEF summary of the August (Perseid) meteor observations at York may be of interest.

Watch was kept on the 10th, 11th, 12th, and 14th. The night of the 11th was very hazy, the nights before the 10th cloudy. There was also much moonlight, except on the 14th. Yet, after making all due allowances, Prof. Herschel thinks that this year's shower indicates a minimum; the last decided minimum being in 1862.

The hourly number on the four nights mentioned were, for one observer, 22, 8, 12, 15, respectively. Perseid radiant and sub-radiants gave 18, 6, 9, 7. Thus, as the shower progressed, there was a regular decrease in the number of Perseids. The apparent exception of the 10th was due to the haze. Prof. Herschel gives 15-20 as the hourly number in Kent. On the 14th half the Perseids came from Mr. Greg's sub-radiant at γ Cassiopeiæ.

In the south large meteors appear to have been scarce. Here eight, brighter than 1st mag. stars, were seen. One, a bolide, low down in the N.W. was very fine. A meteor in the south-west, brighter than Jupiter, was observed by Mr. Waller at Birmingham as a very brilliant object.

The total number observed at York was 105, and 90 of these were mapped. Of the latter 60 were Perseids, 43 with trains. On the 10th five other radiants produced eight meteors out of 53; viz., Cygnus, three; Pegasus, two; Polaris, one; Draco (Hercules), one; and Ursa Major, one. Fifteen meteors on this night were as bright, or brighter, than a 1 mag. star. Only two of 4th mag. brightness were seen, in consequence of the moonlight.

Of meteors stationary, or nearly so, three were mapped:— A Perseid on the 12th at Æ 32½ and δ + 58½, its train lasting 2½ secs.; on the 14th a Cygneid at Æ 306° δ + 35°, and an unknown radiant, probably near 5 Vulpeculæ, gave the third at Æ 295° δ + 28.

Three meteors unmistakably confirm Mr. Greg's sub-Perseid radiant by γ Cassiopeiæ, whilst several others probably radiate from the same. The radiant, Greg 83, by η Draconis, gave two meteors on the 12th and one on the 14th. It is put down, however, as lasting only from July 12 31.

Six Perseids on the 10th, and four on other nights, seem pretty clearly to indicate a sub-radiant at Æ 50°, δ + 40°, near α Persei. The rest, as Prof. Herschel also noticed, shot very constantly from the chief radiant, between η and χ Persei. Here, however, η Persei seemed the most central point.

York, Aug. 15 J. EDMUND CLARK

THE FRENCH ASSOCIATION

IN addition to the notes already given with regard to the forthcoming meeting of the French Association at Clermont, the following particulars relating to the Puy-de-Dôme (furnished by our correspondent there) will doubtless be found interesting:—

Clermont, August 13

The Puy-de-Dôme is connected with most important scientific events, which render it notable amongst more lofty mountains.

Pascal, in 1644, then quite a young man, was apprised by Père Mersenne, the celebrated friend of Descartes, that Torricelli had invented his tube. The then admitted explanation was that nature abhorred a vacuum.

He entered into a correspondence on the subject with Father Noel, a Jesuit professor of natural philosophy in the College of Clermont. Father Noel contended against the very existence of the vacuum, and asserted that the so-called vacuum was filled by luminous matter entering through the glass. Pascal answered by arguments worthy of his genius, and to be recommended for consideration in the discussion about radiometers. He said, "As the nature of light is known to neither you nor me, and as it is very likely it will always be so, I see it will be long before your reasoning acquires the force which is necessary to its becoming the source of any conviction." After having uttered this opinion he reflected more fully upon the subject, and was led to believe that the surplus height of mercury in the tube was equivalent to the weight of the air which could not reach the molecules, being intercepted by the resistance of the glass. This led him to inquire if air-pressure was not lessened by taking the Torricellian tube to the top of a mountain. The experiment was made in Paris first on the top of St. Jacques la Boucherie Tower and Notre Dame. As the difference was found to be only a few lines, Pascal sent his brother-in-law, Perrier, who was a counsellor in the Cour-des-Aules at Clermont, to the top of Puy-de-Dôme with a Torricellian tube. Clermont was supposed to be at an altitude greater than Paris by 400 toises; Font-de-l'Arbre is a village in the vicinity of the mountains where carriages are obliged to stop, at 250 toises from Clermont, and 250 toises from the top of the mountain. All these measurements are incorrect; a toise being 1·94 metres, we find the following differences:—Paris, 60 metres, Clermont, 407; difference, 347 metres, instead of 776, as assumed by Pascal; Puy-de-Dôme, 1,465. Difference between Puy and Clermont = 1,058 metres; according to Pascal only 952 metres.

The loss of mercury from Couvent des Minimes to the top of Puy was found to be 37½ lines; at Font-de-l'Arbre a diminution of 14½ lines from Minimes. A line is equal to 2¼ mm.

Perrier discovered no difference, owing to the wind or state of the atmosphere. Such was not the opinion of Pascal, who discovered that the mercury varies according to the atmospheric conditions of the air. But Perrier was only an amateur experimentalist, and his special ideas had little weight with his clever brother-in-law.

In order to ascertain the fact, continuous observations were made at Clermont, by Perrier, during the years 1649, 1650, and 1651. They were simultaneously made at Paris and at Stockholm, where Descartes was then living at the court of the famous Queen of Sweden. They were continued by Descartes up to the time of his demise.

It is strange that the Pascal experiments were made the very year when Torricelli died, and the results published only in 1664, two years after Pascal's death.

THE SCIENCE DEGREES OF THE UNIVERSITY OF LONDON

WE have received from the Registrar of the University of London a copy of the Report of a Committee, and the new regulations which have been introduced in harmony with that Report, in the examinations for the science degrees. From a perusal of the Report, which we subjoin, all will feel how much is gained by the prompt action of the Senate of the University in so speedily modifying the plan of their examinations in accordance with the experience which they have obtained during the last seventeen years. It is not, however, only experience in the examination of science students which has led to the necessity for change, but the stimulus which has been given to the teaching of physics and biology, by the founding of science degrees and otherwise, has so altered the method of teaching these subjects that what was expected to be known formerly is quite different from that taught by the most able exponents of the subjects at the present time.

No change has been made in the Examination for the Doctor of Science degree, which we regret, because in the Report of the Duke of Devonshire's Committee on Scientific Education great stress was laid on the importance of obtaining an original thesis from each candidate.

The Report of the Committee runs as follows:—

"In accordance with the reference made to them by the Senate (Minute 128, May 13, 1874), the Committee, after having revised the regulations relating to the Degree of Bachelor of Arts, have given a long and serious consideration to those relating to the Degree of Bachelor of Science. It will be remembered that when those regulations were first framed in the year 1859, no guidance was afforded by previous experience, the degrees in science instituted by this University being the first of their kind in the United Kingdom. The Committee by which they were drawn up desired to encourage science students, who might intend to devote themselves to some particular department of science as the pursuit of their lives, to base their special study upon a broad foundation of scientific knowledge; and while the regulations for the Doctorate were framed in such a manner as to permit a high degree of specialisation, the regulations for the Bachelor's Degree were designed to secure the possession of such general culture as should be likely to prevent its holder from becoming a mere specialist.

"Eighteen years' experience of the working of these regulations, however, has made it obvious that the present system is not well adapted to the requirements of scientific education as now conducted. Almost every department of science has undergone a higher development, so as to render it more difficult for a student to obtain an adequate mastery of its fundamental principles and conceptions. Again, it has come to be generally felt that scientific knowledge, to be *real*, must be *practical*, as well as theoretical; and that a thorough knowledge limited to a comparatively small range, is preferable to a slighter acquaintance spread over a more extended area. And it is the general experience of teachers, that there is from the commencement of their academical course such a decided preference on the part of nearly all students of science for either the physical or the biological group of subjects, that the attention of each student is given to one group almost to the exclusion of the other. It was further urged that the *hiatus* is too wide between the almost elementary knowledge of the several departments of science required in the Bachelor's Examination, and the very high attainment in some limited department which is required as the qualification for the Doctorate; and that it would be extremely desirable that this hiatus should be narrowed, by limiting the number of subjects to be brought up by candidates for the B.Sc. Degree, and proportionally raising the standard of proficiency required.

"Several of the ablest teachers in institutions connected with the University, and of its most experienced examiners (past and present), concurred, therefore, in recommending to the Committee, that, keeping the First B.Sc. Examination nearly as it is, an *optional divarication* should be allowed at the Second between the mathematico-physical and the biological subjects; and the Committee, feeling satisfied that such a limitation would be advantageous, proceeded to carry it out, by framing (with the assistance of their examiners and other distinguished men of science) new programmes in the several departments of study, that should suit what are now felt to be their respective requirements. But when these new programmes (in which, wherever feasible, *practical* were combined with *written* examinations) were put together, the conclusion was forced on the Committee, that, even when the whole aggregate of subjects it was deemed right to include was divided into two groups, the acquirement of the proficiency expected in the several subjects thus grouped, would be a task too severe for the average capacities of science students. And after much consideration and communication with their scientific advisers, the Committee have arrived at the conclusion that it would be desirable rather to diminish the number of subjects which each candidate should be required to bring up at the Second B.Sc. Examination, than to exact anything short of the "competent knowledge" of each subject for which these programmes provide. They are further of opinion that each candidate, instead of being required to include either the whole or a part of the subjects he selects in one or other of the before-mentioned groups, should be allowed a free option among all of them, so as to combine them in any way that may best suit his taste and ulterior objects—thus leading him onwards to the still higher specialisation of the Doctorate.

"Acting on this principle, the Committee have framed a new set of regulations for the Degree of Bachelor of Science, which they now submit to the consideration of the Senate. In the *First* Examination, which every candidate will be required to pass, while the programmes in mathematics, experimental physics, and inorganic chemistry have been carefully revised, little fundamental change has been made in them. In place of the superficial acquaintance with both *Zoology* and *Botany* formerly required at this examination, the Committee now recommend a single examination (written and practical) in *General Biology*; in which a more thorough knowledge shall be required of the simplest forms and elementary phenomena of animal and vegetable life, such as is now made the basis of the teaching of some of the most distinguished professors in each department. Thus the student who may be intending to devote himself specially to physical or chemical science, will be brought to apprehend the general conceptions common to the two great organic kingdoms, without being required to master the specialities of either. And the student who intends to present himself at the Second B.Sc. Examination in either physiology, zoology, or botany, or all combined, will have laid the best foundation for those special studies in the study of general biology.

"The regulations for the *Second* B.Sc. Examination, on the other hand, are framed with the view of allowing the candidate to bring up *any three* of the following nine subjects:

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Logic and Psychology.

"It is intended by the Committee that the examinations in these several subjects should be, as nearly as may be, on the same grade, as to the amount of attainment they require. They have learned from the examiners in mathematics, that their experience justifies them in stating that any candidate who has thoroughly mastered the mathematics of the First B.Sc. Examination, and who has such an aptitude for the study as would lead him to select pure mathematics as one of his subjects at the Second, would find no difficulty in mastering the requirements of its programme, by such an amount of study, carried on through an eight months' academical session, as would leave him free to bestow the same amount of time and attention on *two* or even *three other* subjects. And the Committee would wish it to be understood, therefore, that in proposing that each candidate should have his choice of *any three* out of the nine subjects just specified, the amount of proficiency expected in each would be that which he might attain by the steady devotion to it of about one-third of the sessional work of a diligent student.

"With the further recommendation of the introduction of an efficient *practical* examination in each of the subjects in which it is feasible, the Committee now place the mature result of their deliberations before the Senate, with considerable confidence that it is the plan most suited to meet the peculiar requirements of the case, and to promote the best interests of scientific education.

SCIENCE IN ITALY[1]

IN reviewing a number of scientific pamphlets, &c., from Italy, we took occasion to remark (NATURE, vol. xiii., p. 110) that "the restoration of political unity and freedom in Italy has also brought about a revival of that intellectual vigour which we are accustomed to associate with the names of Dante and Tasso, of Galileo and Torricelli. When Italy was divided and each state politically oppressed, her best men were in exile, and their best scientific work was expressed in a foreign tongue."

In forwarding to us a copy of the handsome volume, the title of which is given above, the editors have written to us, quoting the foregoing passage with approval, while the introduction to the volume is written in the spirit of those remarks. It is gratifying to learn what progress Italy has made during the last ten or fifteen years in education, literature, science, commerce, and industry. "An air more propitious to study is now breathed by united Italy." New scientific schools, institutions, and societies have sprung up, and the old have been renovated. The best men, returned from exile, have resumed their place among the explorers of nature; and the present state of intellectual activity only renders more evident the condition of misrule and division which so long afflicted that noble country, when all free inquiry, whether in nature or in politics, was forbidden, or at least discouraged. In singular contrast to all this, her best minds have at length found that intellectual repose and encouragement at home which are so essential to the carrying on of grave studies.

As an exponent of this new state of things, the editors conceived the idea of publishing a half-yearly report of the scientific progress of Italy; and taking advantage of that wide spirit of tolerant liberality which pervades all true science, they appealed for support to such of their countrymen as were distinguished in the various departments of physics, chemistry, mineralogy, geology, botany, zoology, physiology, anthropology, and geography. This appeal was most liberally and heartily responded to, and the result is a large octavo volume of about 450 pages, well written and carefully edited, very few mistakes occurring, even in the spelling of well-known names, although we find at p. 15, "Poulliet," at p. 68, "Bences Jones," at p. 84, "Edvard Hull," and this odd mode of division at p. 15, "Hel-mholtz." The contributors to these various departments have performed their respective tasks nobly and well. They have not only contributed voluminous abstracts of papers, notes and memoirs, but in many cases have furnished more or less elaborate reports on the state of their respective branches of science, and have also given, in some cases, reviews of the best books by Italian authors. For example, the reporter on mineralogy, in addition to some sensible remarks on the backward state of science in Italy, devotes thirty full pages to a review of Bambicci's "Corso di Mineralogia" (second edition, 1875), and refers to it again and again in terms of such high praise as would seem scarcely to belong to a compilation from standard writers in other languages. Indeed the superlative terms of laudation which occur in many parts of the volume strike our colder northern temperament as being at least exaggerated. Why refer to the *chiarissimo Signor Professore*, So-and-So, while foreign *savans*, whether living or departed, are simply and properly mentioned, as Ampère, Faraday, Helmholtz, &c. When Lord Castlereagh appeared in plain evening dress at a brilliant party at Vienna, amidst a crowd of highly-decorated gentlemen, a lady, asking Metternich who he was, said, "Mais il n'est pas distingué!" that statesman replied, "Ma foi! c'est être bien distingué."

Although we are bound to bestow cordial praise on this volume, yet we should not perform our duty honestly if we omitted to point out a certain backwardness on the part of some investigators in reading up their subjects before they attempted to make what to them appear to be new researches. For example, at p. 66 is an abstract of a memoir by Pelloggio, entitled "Contribution to the Phenomena of Supersaturation," in which the author appears to have no more recent information of his subject than that derived from Löwel. He points out that salts isomeric with the one in solution act as nuclei to it. This was shown to be the case many years ago by Violette. He also insists that porous bodies, such as sponge, charcoal, &c., are powerful nuclei; whereas it has been shown by Tomlinson that such bodies, boiled with the solution which is then left to cool, are purely passive. So also when MM. Mercadante and Colosi affirm (p. 47) that carbonic acid is not emitted by the roots of plants, they are evidently unacquainted with Broughton's researches. We may also point out what seems to be an inaccurate observation on the part of Pollacci (p. 50), namely, that sulphur moistened and exposed to the air absorbs oxygen and becomes converted into sulphuric acid.

At p. 126 there is an interesting account of the fall of a meteor at Supino in the district of Frosinone on Sept. 14, 1875. It was accompanied by a trail of fire and smoke; and after reaching the earth it took a horizontal direction, passed through a house without striking it, thanks to an open passage, and so disappeared. A number of fragments were found in the passage, the heaviest of which weighed 364·2 grammes. The fragments were warm. At p. 134 is a paper on red chalk, which would deserve attention did our space permit.

Anthropology and ethnology are comparatively new to Italy, but they have begun a life of apparent vigour under the auspices of a new society, a museum, and a journal.

There are some interesting details respecting the skulls of Dante, Petrarch, Ugo Foscolo, and Volta, the last being of extraordinary capacity. In the skull of Petrarch the Etruscan type is said to be evident, namely, a voluminous brain, strongly developed in all its parts, and of superior psychological power; but the posterior predominates over the anterior portion, leading to the conclusion that the sentiments and the instincts prevailed over the intellect, although this is of the highest order.

We look out with much interest for the second part of this volume, which the editors promise shall appear shortly.

C. TOMLINSON

[1] Half-yearly Review of the Physico-Natural Sciences in Italy. Edited and published by Drs. G. Cavanna and G. Papasogli. Anno I., 1875, vol. i. Florence, 1875. (*Rassegna Semestrale*, &c.)

THE VOLCANO OF RÉUNION[1]

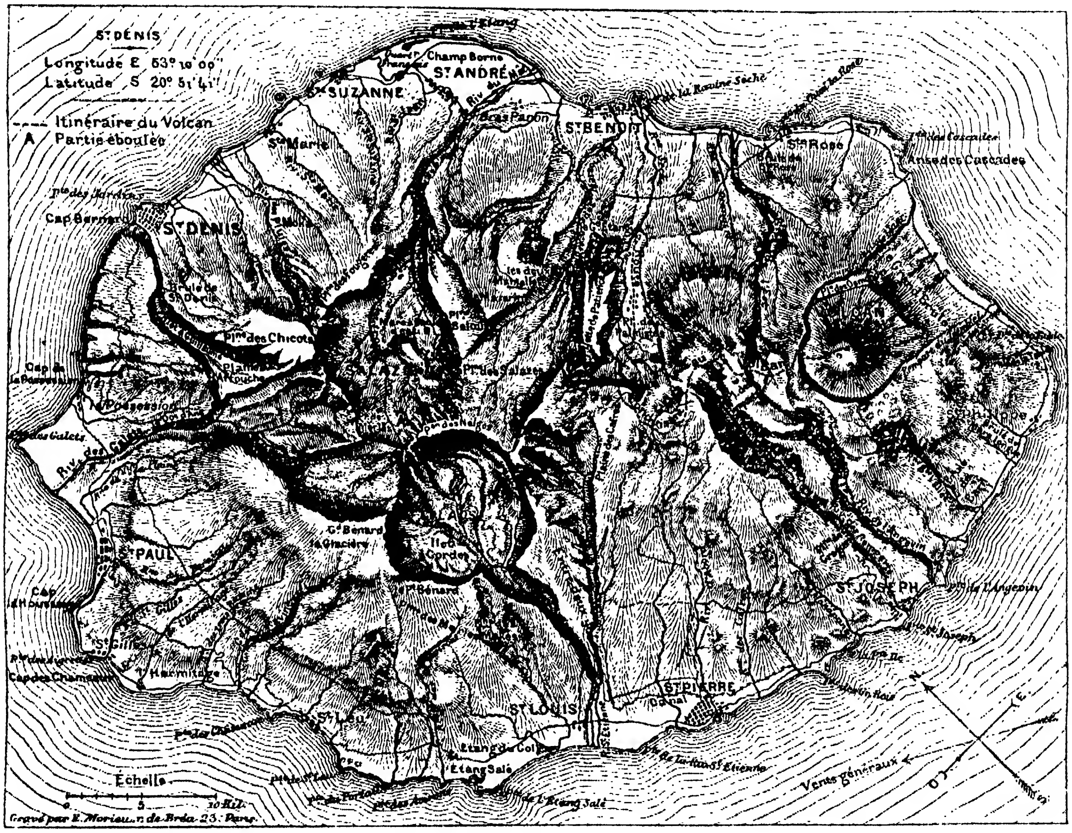
THE volcano of the Island of Réunion, surrounded and defended as it were by great circular walls perpendicular for more than 100 metres, forming what is known as the inclosure, is hardly accessible except on two sides, by the high plain of the interior or by the Grand-Brulé; that is, setting out from the coast to climb directly the slopes of the crater itself.

Far from becoming extinct, as has been supposed, this volcano is on the contrary in great activity, and almost every year torrents of lava overflow in that western part of the island known as the great burnt country; its streams sometimes reach the sea, and there form, at a height of more than 2,000 metres, a regular cascade of fire, which may reach a length, as in 1844, of from 900 to 1,000 metres. But these great eruptions are happily very rare; they are only seen at intervals of six or eight years, and very often the lava is arrested 1,000 or 1,500 metres from the mouth of the crater. Towards the end of August, 1874, loud detonations, sudden tremblings of the ground presaged an eruption of great violence; but the flow lasted only two days; directed towards the rampart of the Tremblet, it was happily arrested at 1,500 metres without causing much damage. It was then that I arrived

[1] From an article in *La Nature*, No. 160, by M. Ch. Vélain.

in the harbour of St. Denis; and on landing I organised, with MM. Rochefort, Cazin, and De l'Isle an expedition to the volcano in the hope of arriving in time enough to witness the end of the eruption. We set out from St. Benoît on Sept. 1, and made for the plain of Palmistes, our first stage. This plain is surrounded on all sides, except the north-east, by perpendicular ramparts, which may reach a height of 200 metres, and whose sides, covered with vegetation, form a semicircular curtain of verdure that shuts out the horizon.

From the plain of the Palmistes we had to climb to that of Cafres by crossing the rampart of the Grande-Montée, a long and difficult ascent on account of the abruptness of the rampart. We reached the summit about an hour after mid-day, and fo nd the temperature to be 14° C., less than half that of the lower part of the island. The plain of Cafres, at a mean height of 1,600 metres, forms a declivity, a sort of saddle-back or pass between the two parts of the island which we have distinguished under the names of Ancient Mass and Recent Mass. It is a very uneven plain, inclined towards the south-west, *i.e.*, in a direction opposite to that of the Palmistes, and formed by a succession of small echeloned plateaus crossed by rounded hillocks covered with vegetation. The soil which results from the disintegration of the lavas is here very argillaceous, as all that savannah presents fresh pasturage during the dry season, and is changed into a vast marsh during the rainy season; it is about two leagues in length. Night surprised us near the source of the river of the Ramparts before we could reach the end of our journey, and we had to sleep on the bare ground; the thermometer reached 3°, and during the night sank to −2°.



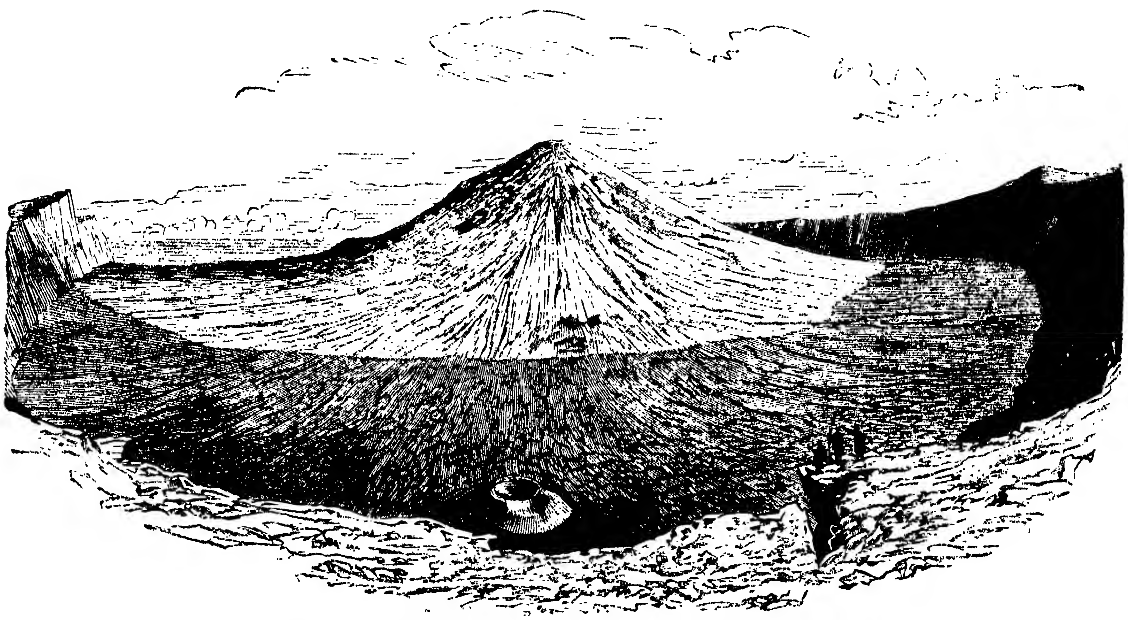
Map of the Island of Réunion (after M. L. Maillard).

At eleven on the next morning we reached the Cavern of the Lataniers, after having visited the vast crater named Commerson, singularly situated on the very edge of the magnificent escarpments which form the great section at the foot of which flows the river of the Ramparts; from thence we directed our steps towards the pass of the sands (2,386 metres), in order to cross the first inclosure of the volcano. The present volcanic cone is, in fact, preceded by two great circles produced by subsidences which have given place to veritable circular walls cut perpendicularly for more than 100 metres from the top, and which are named the inclosures. Of the first there remains only a small part; on the north-east its wall overhangs the river from the east, and on the east the plain of sands; but on the south it is not so easily traced; it is prolonged on this side of the great section of the river Angevin, the formation of which is later.

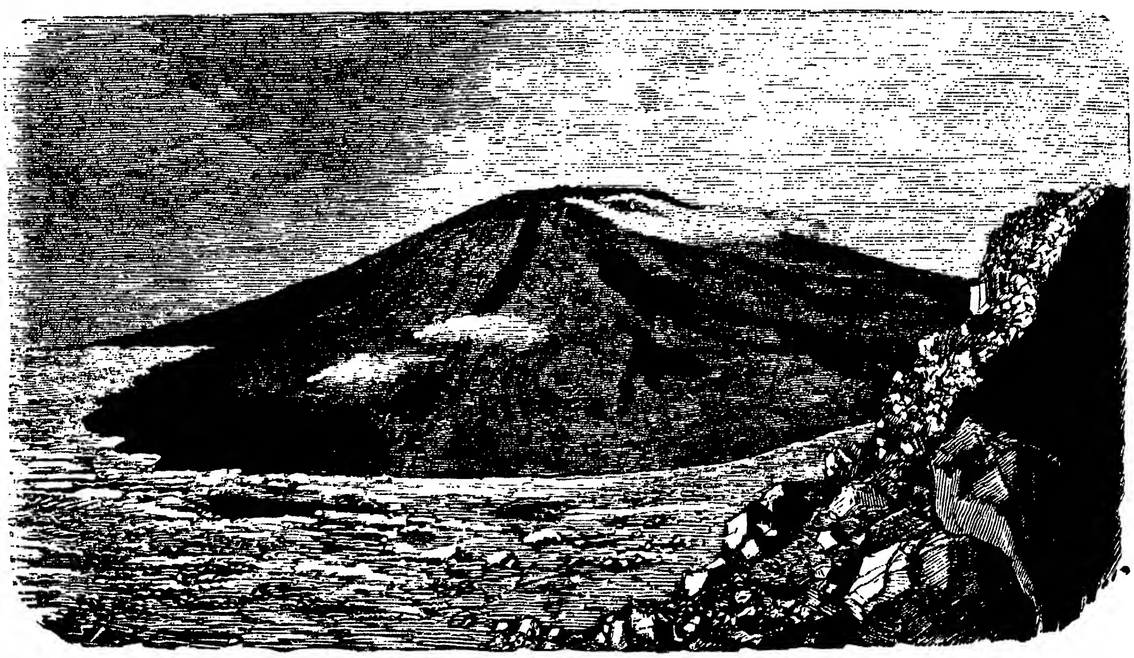
The plain of sands (about 2,300 metres) which thus circumscribes a basaltic rampart, is formed by a black compact lava covered by a layer of small angular very regular fragments of vitreous lava, often two metres in thickness. In the bottom of the little ravines is noticed, moreover, an accumulation of crystals of olivine and augite which come from the disintegration of certain rocks thrown out by the volcano, and composed almost solely of these two minerals. It is intersected by cones of scoriæ regular in form, terminating in little craters, the limited overflows from which appeared consolidated on the ledge. We had to pass round many of them before arriving at the ridge of the second inclosure, which had

to be crossed at the Belcombe pass (2,400 m.). The diameter of the latter is about 5,000 metres ; it is disposed in horsehoe form, and is prolonged eastwards by two great parallel walls, which are named respectively the Rampart of Bois Blanc and the Rampart of Tremblet, and which surround the great burnt region ; here is the mass of the present volcano.

When we reached the top of the rampart the descent looked dreadful, and appeared perpendicular to a depth of 250 metres. Below, sombre-coloured lavas stretched out in a sort of platform which serves as a base to the volcanic mountain, whose slopes they cover to an equal height all round ; there is detached from the foot of the rampart a little cone of scoriæ in admirable preservation.



The *Formica-leo* and the Bory Peak (extinct crater) from above the Pass of Belcombe.



The Inclosure and the Cone of the present Crater.

which Bory de St. Vincent has named the *Formica-leo* (Ant-lion). Attempting the descent by the help of some shrubs which had lodged themselves in the interstices of the wall, we reached with difficulty the base of the escarpment. The *Formica-leo*, which, seen from above, appeared quite near, was more than 300 metres from us.

It is a very flattened cone, perfectly regular, 15 metres high on a base of from 1,000 to 1,200 metres, presenting at the summit an opening of about 80 metres, with a depth of 6 metres. It is formed entirely of bright-coloured scoriæ, black, yellow, but mostly red.

On the morrow, after having passed the night under a break in the lava of the rampart, exposed to the moisture and to a glacial wind, we ascended the slopes of the Bory Peak, in order to reach the burning crater. On our arrival at the mouth of the crater all the volcanic phenomena had ceased; on the slopes of the cone, formed of scoriæ and heaps of ashes is detached a black stream of vitreous lava which made its way by numerous fissures to about 100 metres from the summit. The cooled lava formed at the bottom of the crater a circular shaft about 80 metres in depth, like a solid crust much fissured. Abundant vapours escaped from various points in the walls, which presented alternate streams of lava and scoriæ, covered, especially towards the summit, by a whitish coating, formed of the crystals of gypsum. The lava of the last eruption had flowed to the north-east towards the plain of Osmondes; it was not very extensive, very scoriaceous, bluish-black, and entirely vitreous. It must have been accompanied or followed by numerous ejections and particularly by a rain of those volcanic threads so frequently thrown out by the volcanoes of the Sandwich Islands, and known as Pelé's Hair; for these brown filaments, which are simply wire-drawn obsidians, bedecked all the irregularities of the lava. In the crevasses which crossed the last flow, the temperature was 50°·7 near the surface, and about 72° at 2 metres below. The vapours of water and of hydrochloric acid were given off at frequent intervals here as well as at various points of the escarpment which directly preceded the volcanic cone. A small inclosure, not hitherto referred to, surrounded the crater; its precipices were about 60 metres high. The mass of the volcano is thus composed of two peaks, the highest of which (2,625 metres) supports the crater Bory, extinct since the beginning of the century; while the other (the Fournaise peak, 2,515 metres), which is of later formation, supports the active crater. The products of this volcano are composed mainly of basaltic or vitreous lavas rich in chrysolite; this mineral, so characteristic of modern eruptions, is often ejected in voluminous and compact masses. The products of the old volcano, which must at one time have occupied the centre of the three valleys of Cilaos, Salazie, and Mafatte, are quite different; they are scattered over a trachytic mass which is only seen, however, in the beds of the torrents which drain the three circles above referred to.

Our porters, whom the sight of the volcano deeply impressed, were unwilling to follow us on to the lavas; they remained at the Belcombe Pass, and would not on any account on our return take charge of the rocks and volcano products which I had collected. Some maintained that stones were plentiful enough on the shore, and that it was useless to carry them from such a height; others, affecting a gross superstition, would not touch what came from the "fire of the good God." I had to use a little trickery, and take advantage of the darkness to slip into their sacks my day's collection.

ARCTIC FOSSIL FLORA [1]

THIS third volume of Dr. Heer's "Fossil Flora of the Arctic Regions" contains four very distinct chapters. The first of these relates to the Plants of the Coal-measures of the Arctic Zone; the second to the Plants of the Chalk Formation of the same Zone; the third gives an account of the Miocene Flora of Greenland; and the fourth is a review of the Miocene Flora of the Arctic Zone. For the material for the first three chapters of this volume the author has the Swedish naturalists alone to thank, and in addition, the Swedish Academy of Sciences has been at the expense of the several parts composing it, which will also be found in Vols. 12 and 13 of their "Abhandlungen." The fourth chapter is added at the expense of Dr. Heer, and not only notices the Miocene plants referred to in the three first volumes, but also those collected during the summer of 1873 in Spitzbergen by Prof. Nordenskjold.

It would not be desirable here to do more than notice the general contents of this quarto volume, which contains notices of four species of plants found in the lower coal-measures of Spitzbergen; of seventy-five species from the lower and of sixty-five species from the upper chalk of Greenland, of sixteen species from the chalk of Spitzbergen, and of thirty-four species from the Miocene of Greenland, most of these species are illustrated in the forty-nine plates which accompany the volume. One remarkable fern, *Protopteris punctata*, Stbg., is referred to in the text as a proof of the occurrence of the coal-measures at Ujarasusuk at Disco. It was originally described from specimens found in the sandstone of Kaunitz, in Bohemia, which had been most generally described as belonging to the coal-measures; it would seem, however, from the researches of Herr Feistmantel that the Kaunitz sandstone really belongs to the chalk formation, thus doing away with the only point which for a moment seemed to favour the existence of the coal formation in Greenland, seeming to prove that on both sides of the Waigat, at Disco, and at Half Island, Noursoak, the oldest sedimentary formations are chalk deposits. These from the former locality apparently belong to the Upper Cretaceous period, while the dark-brown rocks and sandstones of the north side of the latter locality belong to the Lower Cretaceous period. Higher up succeed the Miocene deposits, which are covered and penetrated by intrusions of the mighty basalt rock.

From the many various localities now known in the Arctic regions for fossil plants, none indicating a marine origin have occurred to Dr. Heer. Steenstrup, jun., however, has detected the remains of some marine animals from the district of Atane, between Patut and Nück Kiterdlek; here, in several places at an elevation of some 2,000 feet over sea-level, he found Echinoderms and marine shells. *Cyclostigma Nathorsti*, very near *C. Kiltorkense*, Haughton, is described as new from the coal of Spitzbergen.

A glance at the list of the Miocene plants shows how changed the seasons in the Arctic Zone must be from the time when these plants were living and bearing the leaves which have been so well preserved. Hawthorn and brambles, walnuts, magnolias, and vines, not to allude to planes, Macclintockias, and many of the more delicate Conifers, seemed to have flourished ere the reign of ice came and burnt them up. The list of cretaceous fossil plants from North Greenland is accompanied by a list of the localities where they were collected. The collection, a very large one, is for the most part in the museum at Stockholm; many of the species are described as new. The absence of insect life amid all this plant life is noteworthy, but two species, probably weevils, being described in this volume.

Many countries have contributed the material for Prof. Heer to work out the history of the "Flora of the Arctic World." A great deal still remains to be done. Now that England, Denmark, and Sweden have done so much, we must look to Russia to contribute according to her means and the extent of her Arctic possessions; she has done nobly in tracing out the contour line of her northern coast. We would now know more of the rocks that form it.

E. P. W.

[1] "Flora Fossilis Arctica." Die Fossile Flora der Polarländer von Dr. Oswald Heer. Dritter Band. (Zurich, 1875.)

OUR ASTRONOMICAL COLUMN

The Double-Star B.A.C. 1972.—Capt. Jacob, reviewing the measures of this object, first registered double by Dunlop with his 9-feet reflector at Paramatta (No. 23 of the Catalogue of 253 stars), remarked of it in 1858: "the angle is, on the whole, evidently advancing, and the distance decreasing, but the measures are strangely wild, considering the easiness of the object, and seem to indicate the presence of some perturbing body." For comparison the following may be selected:—

Dunlop ...	1826·00	Position	329°·0	Distance	3″·00
Herschel ...	1835·02	„	342·5	„	3·86
Jacob ...	1846·94	„	348·5	„	3·22
„ ...	1852·73	„	350·7	„	2·81
„ ...	1858·17	„	354·7	„	2·18

Jacob's measures of 1858 are the last we find; he considered an appulse would take place about 1875.

Dunlop says of the results in his catalogue similar to the above, the "positions and distances are only estimations while passing through the field of the 9-feet telescope," and no great stress, therefore, need be placed upon them. If we assume that the change of angle and distance is the effect of proper motion, a comparison of Sir John Herschel's measures of 1835, with the later ones at Madras, leads to the following formulæ:—

$$\Delta\alpha = -0''.7876 + [8.80975](t - 1850)$$
$$\Delta\delta = +2.6026 - [8.81000](t - 1850)$$

Whence we find for 1876·75, position 34°·4, distance 1″·13, showing a considerable change since the last published measures, which should render it easy for one of our southern readers to decide upon the cause of the apparent motion. In the case of rectilinear motion the nearest approach would fall in 1881 or 1882, on an angle of from 50° 55°, and in 1891 the component which we are taking for the companion (though the stars appear of equal magnitude—the seventh) would be upon the parallel following 1″·2. So much is to be gathered from the data at present in our possession. The position of the star for 1876 is in R.A. 6h. 1m. 35s., N.P.D. 138° 27′.—It should be added that the above formulæ give an angle of position for 1826·0, differing 11° from Dunlop's estimation and the distance greater by 2¼ seconds.

The Second Comet of 1844.—The period of revolution assigned to this comet by Prof. Plantamour, of Geneva, after a most minute discussion of the observations, is upwards of a thousand centuries, with a probable error of about thirty centuries! Such a result may be regarded with suspicion by many, but let us see upon what grounds it has been founded.

The second comet of 1844 was independently discovered by Mauvais, at Paris, on July 7, and two nights later by D'Arrest, at Berlin. It was observed before the conjunction with the sun and perihelion passage until September 7, and was found at the Royal Observatory, Cape of Good Hope, on October 27, and observed with great precision on forty-eight days at that establishment until March 10, 1845, when it was distant from the earth 2·9, and from the sun 2·4. The later European observations are those taken at the Royal Observatory, Greenwich, on March 4, and at Berlin on March 6. 545 observations of position were available for the determination of the orbit, and are discussed in the *Mémoire sur la Comète Mauvais de l'année*, 1844, by Prof. Plantamour. He started with the parabolic elements of Nicolai, which had led to the re-discovery of the comet in Europe after the perihelion passage, on January 27, 1845. The perturbations due to the action of Venus, the Earth, Jupiter, and Saturn, during the whole interval of observation, were rigorously determined and taken into account, and after a double solution of equations of condition founded upon normal positions, thus freed from the slight distortions due to planetary attraction, the deviation of the eccentricity from unity was found, with a probable error of only $\frac{1}{30}$th part of the amount of this deviation. The resulting definitive orbit is an ellipse with a semi-axis major = 2183·8; the corresponding period is 102,050 years ± 3,090. This value of the time of revolution is founded upon an arc of the comet's orbit, extending to 204°, described in eight months.

The aphelion distance of the comet is 4,366 times the earth's mean distance from the sun, a space which light would require twenty-five days to traverse, and yet little more than a fiftieth part of that of the nearest fixed star according to our present knowledge, a suggestive fact when the visits of comets to other systems are under discussion.

New Nebulæ.—M. Stéphan, Director of the Observatory at Marseilles, has communicated to the Paris Academy a list of twenty-three new nebulæ detected with the Foucault telescope of 0·80 m. aperture, which raises the number of such discoveries, so far published, to 120; but M. Stéphan mentions that he has approximate positions of about 400 new nebulæ, between 45° and 100° N.P.D., and hopes yet to considerably increase this number. As might be expected, the twenty-three new nebulæ are mostly very faint; one only is called "pretty bright—very small—round" in R.A., 17h. 6m. 47s.; N.P.D., 48° 11′·7, for 1876·0.

THE NORWEGIAN NORTH ATLANTIC EXPEDITION

Reikiavik, July 27

In continuation of our last account we hear that the expedition has been not at all favoured by the weather. Since it left Christiansund, June 27, it has met with no less than five storms (wind velocity, forty-five miles an hour); two in the "Lightning" Channel early in July, one at Thorshaven, one north of Faroë, and one at the Westman Islands (off the south coast of Iceland). It has been only in the short intervals between these storms that any deep-sea work has been done. The last days of June were fine, so the expedition sounded, dredged, and trawled off Christiansund on the bank called "Storeggen." Here the fauna was quite Atlantic; on the outer edge of the bank the water deepened to 300, 400, and 500 fathoms, and the ice-cold water was met with, yielding an Arctic fauna. Two large specimens of *Umbellularia* (the same as earlier) were found, with a new star-fish and an animal which is quite new to the naturalists on board. Of smaller organisms there were also several new ones.

In lat. 63° 10′ N., long. 1° 30′ W., a sounding in 1,050 fathoms gave a temperature under 32° below 300 fathoms. The *Voringen* had to leave this station to refit, as a sea had carried away the two fore-hatches. The course was shaped for Thorshaven, where the expedition stayed eight days to refit (July 8-15). The stay there was very interesting, especially for the geologists. The formation of caverns at sea-level was an operation visible in all stages of progress. In the zoolite caverns of Naalsö a rich harvest of minerals was secured.

The inhabitants of Thorshaven received the expedition very hospitably, and remembered, with great pleasure, the stay of the *Lightning* and *Porcupine*.

After a trip round the main island to Westmanhaven, the *Voringen* left Faröe, July 16, and steered for its last station. Bad weather brought work here to a speedy conclusion; however, a series of temperatures were obtained, indicating ice-cold water at a depth of 300 or 400 fathoms. On the north-eastern corner of the Faröe bank the depth increases very rapidly. In lat. 63° 22′ N., long. 3° 30′ W., soundings gave 1,180 fathoms. A series of temperatures gave 32°·4 in 400 fathoms, 31°·8 in 500 fathoms, and the bottom temperature was 29°·8. In lat. 63° 55′ N., long 7′ 10′ W., 30°·2 in 677 fathoms; in lat. 63° 3′ N., long. 10° 15′ W., 37°·2 in 256 fathoms. Further

west the bottom temperature was found to be $46^{\circ}.2$. Bad weather prohibited dredging, so the course was laid for Reikiavik, but heavy S.W. winds and sea made the progress very slow. July 22, Iceland was made in the morning, but in the afternoon the weather got so wild and thick that shelter was sought at the Westman Islands, a group of small islands off the south coast of Iceland. Here a stay of three days was made; during one of them there was a heavy gale, in which steam was kept up. The visit here proved very interesting. The whole of the islands are volcanic; a large old crater, with perpendicular walls 400 to 500 feet high, is visible; one side is standing, the other has been washed away by the sea. Two miles off is a more recent cone, 770 feet above sea-level, in full preservation, with a hollow 50 feet deep on top. The base of the cone is lava; the cone itself, whose outline is beautifully geometrical, is composed of loose stones. The sea-birds are very numerous, living in the countless hollows in the cliffs, where they were hatching at the time of the visit. Whales, large and small, were about the ship.

Westmaney was left July 26, and Reikiavik reached that evening. On the south coast of Iceland the current was very strong to the eastward, and from Cape Skagi to Reikiavik its violence was fearful.

The Icelanders reported that they have very seldom had so bad a summer as this one—perpetual storm and rain. This has not been favourable to the expedition except as regards meteorology. In this branch hourly observations have been regularly taken when at sea.

The expedition was to stay at Reikiavik five or six days for coaling and for magnetic base observations. Hardly any magnetic observations have been obtained at sea, the weather having been so boisterous. It was intended to give up making the circuit of Iceland (the ice on the north side went away in June), and to take up a line south of Iceland, and then straight across to Norway, about to Namsos. The scientific staff is very well contented with the results gained, in spite of the bad weather.

(*From another Correspondent.*)

The Atlantic Expedition, under the leadership of Prof. Mohn and Prof. Sars, sent by the Norwegian government for the exploration of the North Atlantic and for making a *tour* round Iceland, give some intelligence as to their proceedings in a letter from Thorshavn (Faröe Islands), dated July 11 and 14, printed in the Christiania newspaper, *Morgenbladet*, of Aug. 2. This letter, the substance of which we reproduce, gives information on the cruise of the expedition in open sea, after its having left Christiansund. On June 27 the steamer left Christiansund and went westward. In the evening soundings were taken at a depth of 87 fathoms, and the temperature of the water proved to be as high as 7° C., between 10 fathoms and the bottom. The following day, the island Storeggen was reached; the temperature of the water was here $7\frac{1}{2}^{\circ}$ C., at a depth of 230 fathoms, and the animal life, belonging all to the "warm region," was of the highest interest. On the 29th, the steamer going further westward, the depth still increased and soon reached 418 fathoms, where the thermometer showed an icy-cold sheet of water, sharply divided from the upper warmer sheet, the temperature at 300 fathoms being $+6^{\circ}$, and -1° at the depth of 418 fathoms. On the 30th the weather was very fine, and the trawl-net was used, an English fishing-net, which brought some remarkable forms (*e.g.* large *Umbelliferæ*) from the depths of the cold sheet of water. On July 1 the thermometer showed -1° C. at the depth of 570 fathoms. In the afternoon the weather changed, the wind began to blow very strongly from S.S.E., the barometer fell, and the steamer took a S.E. direction. On July 2 the wind reached the strength of a storm, the waves had a height of 18 feet, which height diminished afterwards to 12 and 10 feet. The bad weather continued until July 4, and it was not till the 5th that the steamer could return to her former route, and the soundings and the fishing could be continued. On the 5th soundings were taken at a depth of 1,050 fathoms, temperature at the bottom -1° C. The dredging apparatus was sent to this depth, and dragged for six hours: it brought up a very interesting collection, which proved that even at this depth, and in such cold water, animal life is very variable at different parts of the bottom. But the zoological labours were soon interrupted anew by a gale coming from the south; the height of the waves was measured and found to be 25 feet, and the steamer received some damage, which forced the expedition to go to the Faröe Islands. On the 8th the expedition landed at Thorshavn, and it was not till July 14 that, necessary repairs being made, the steamer could go further. These circumstances, and the reports of much ice round Iceland made it very probable that the expedition will not make, this year, the proposed *tour* round that island.

The scientific results of the expedition—says the writer of the letter—are already considerable. The depths of the sea, and the distribution of temperature with the depth are certainly such as might be supposed, but the animal life exhibits a much greater variety of forms than could ever have been expected, so that the explorations of the summer will give a very general idea as to the organic life of this latitude.

MR. O. C. STONE'S EXPEDITION TO NEW GUINEA

A GOOD deal of speculation has been rife as to the above expedition of Mr. Stone (Cf. *Ibis*, 1876, p. 363) into south-eastern New Guinea, as the collections sent by the Italian traveller, D'Albertis, had by no means answered the expectations of naturalists as regards novelties, and as Mr. Stone was known to have engaged the services of two good *préparateurs* in the persons of Messrs. Petterd and Broadbent, it was confidently expected that a great deal that was new to science would be brought to light. After a cursory examination of the birds obtained during the expedition, it becomes quite evident that the neighbourhood of Port Moresby is a very unproductive one as regards ornithology, when compared with the rich fields in the north-western part of New Guinea, which have lately yielded as many as fifty-two undescribed species of birds to the Italian traveller, Dr. Beccari. At the same time Mr. Stone's collection has taught us some very interesting facts by proving that the Papuan element in the avifauna of south-eastern New Guinea, consists rather of Aru forms than of Salwatti or Dorey species. Many birds are, as might be expected, specifically the same as those of Cape York, but the large number of Aru birds is very striking. I am preparing a full account of the collection for publication, but meanwhile I send a notice of the expedition for the readers of this journal, and add short details of one or two species which appear to be new to science.

Mr. Stone started from Somerset, Australia, on October 21, 1875, and after remaining a few days at Yule Island, where Signor d'Albertis was then collecting, he reached Port Moresby, New Guinea, about sixty miles further to the south-east, on the 29th of the same month. Although his principal object in visiting the island was to gain ethnological and geographical information, he took with him, as mentioned above, two taxidermists. Anuapata, where he erected his tent, is situated upon the shores of Moresby harbour, in long. 147° 7′ E., and lat. 9° 28′ S., and from here several preliminary excursions were made. At first the natives showed some fear, but on seeing that the object of the visitors was peaceable, they soon gained confidence, and the younger members of the community frequently assisted in carrying back the game shot. During the months of December and

January rain fell in considerable quantities, and both the collectors were laid up for many days with fever and ague, which retarded collecting, but altogether about 450 skins of birds were obtained from a radius of about thirty miles inland from Port Moresby. In the immediate neighbourhood of Port Moresby birds were plentiful, but the beautiful Bird of Paradise (*P. raggiana*) is only found in the thick forests on the mountains of the interior. Parrakeets, parrots and cockatoos, pigeons and doves, were numerous among the jungle, and the belts of tall trees along the rivers Laroki and Vetura. The farthest point reached inland was Munikaira, situated about thirty miles to the north-east, the difficulty in procuring natives as carriers preventing Mr. Stone from proceeding further; at this point he made a camp for several days, but the wet season and consequent unhealthiness of the place precluded further exploration.

The following birds appear to be undescribed:—

Æluredus stonii, Stone's Cat-bird, like *Æ. buccoides*, of N.W. New Guinea, but distinguished by a black head and unspotted abdomen. Hab. Laroki River.

Dicæum rubro-coronatum (Red-crowned Flower-pecker). Although having a red spot on the breast, like *D. vulneratum*, *D. schistaceiceps*, &c., this species differs from them all in having the back purplish, with a scarlet crown and rump. I cannot find any species agreeing with it. Hab. Port Moresby.

Janthænas rawlinsoni, closely allied to *J. hypænochrous*, but differing in its crown being of a ruddy violet, the under tail-coverts being black, and the under-surface also ruddy violet, without the strong chestnut appearance of *J. hypænochrous*. Hab. Laroki River.

R. BOWDLER SHARPE

ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE[1]

VI.

Experimentation with Nitrite of Amyl.

IN the progress of scientific therapeutics no addition to the curative resources of medicine has of late attracted more attention than the nitrite of amyl. This agent is now one of the useful agents in the hands of the physician, and, what is most to the purpose, it is one of the most useful for relieving the cruellest and painfullest diseases. The discovery of the properties it possesses resulted in the purest way from experimental study, the record of which I am entitled to write as the one who introduced the agent into medicine, defined its mode of action, and thereby determined its place in the lists of curative chemical substances.

Nitrite of amyl was discovered by Balard thirty years ago. It was examined afterwards by Rieckher. It was made by the action of nitrous acid on amylic alcohol, and the vapour of it was said to produce headache when it was inhaled. Many years passed before any further observation was made upon the substance, and indeed, Gregory, in his edition of "Organic Chemistry," published in 1852, merely refers, and that incidentally, to the nitrate of amyl. He passes over the nitrite in silence.

The observation that the vapour of nitrite of amyl causes headache, or rather a sense of fulness of the head than headache, rested, I believe, on the observations of Rieckher, and was not improved upon until Prof. Guthrie, of Edinburgh, and now of the School of Mines, London, noticed, while distilling the nitrite, the further facts that the vapour, after being inhaled, induces flushing of the face, rapid action of the heart, a peculiar breathlessness such as occurs from fast running, and disturbance of cerebral action. These facts, published by the learned professor, became known to Mr. Morison, a dentist practising in Edinburgh. Mr. Morison thought that the vapour of nitrite of amyl might be a powerful stimulant, and might be made use of in cases of syncope and exhaustion. He brought a specimen of the compound to London, and placed it before the College of Dentists, of which he was a member. The Council of that Institution thereupon submitted the specimen to me for investigation and report, with the request that I would fully inquire into its physiological and therapeutical properties by experiment.

The first public record of my researches, commenced in this manner, was read to the physiological section of the British Association for the Advancement of Science at the meeting of the Association held at Newcastle-on-Tyne in 1863. It is unfortunate that by some accident the original paper as it was read at the meeting was not included in the volume of Transactions of the Association. A short and fair abstract of it was, however, published in the *Medical Times and Gazette* (Sept. 26, 1863, pp. 334-5). The first remarkable effect I observed upon the living body from the vapour of the nitrite was the peculiar redness of the skin. On the face a deep blush was excited by inhalation of the vapour, which blush soon became a perfect crimson. With this there was a rapid increase in the motion of the heart, and following upon the same there was quickened respiration and panting. These observations, which resembled those noted by Prof. Guthrie, were taken in a systematic manner from symptoms produced on myself. A piece of paper was rolled into the form of a funnel, the nitrite was dropped into the open mouth of the funnel, and then I inhaled vapour from the funnel until distinct objective and subjective symptoms were recognised. Dr. Gibb, afterwards known as Sir George Duncan Gibb, took notes of these signs as they were developed in me, and then he himself inhaled while I recorded symptoms. Afterwards Mr. Kempton, a member of the Council of the College of Dentists, submitted himself to experiment. The result was the confirmation of certain very extraordinary phenomena induced by the nitrite, but what the nature of those phenomena could be was unknown. One thing was certain, that here was an agent of great potency in its action on the animal economy, and therefore of promise as an agent for cure. The question was what disease would it cure or alleviate? Towards the relief of what class of human maladies could it be applied?

I should have been well content if I could have pursued this inquiry solely by observation on man. But soon I found that the experimental pursuit on the human animal was far too dangerous a risk to be ventured upon. An enthusiastic adventurous experimentalist in my laboratory made a few inhalations too many, and well nigh paid the penalty with his life. The rapid action of his heart was followed by confusion of the senses and by sudden prostration, and extreme pallor and faintness from which there was not a safe recovery for two hours, nor a complete recovery for two days. The only lesson taught by this experience was that the original idea of using nitrite of amyl for the cure of syncope was false. All else was as dark as ever, and if I had had no other means of research at command, I should have laid this now valuable remedy aside as a dangerous substance, a substance not to be added to the armoury of practical medicine.

In this dilemma it seemed to be justifiable to test the action of the agent on animals inferior to man.

The first point to be ascertained was whether this substance acted after the manner of an anæsthetic. Animals therefore of different classes, frogs, guinea pigs, cats, and rabbits, were subjected to its vapour as I had been; but the inhalation in their case was carried further, and they were allowed to pass into insensibility. The insensibility appeared to be death, and in the warm-blooded animals was death. The consciousness of external impressions remained until the moment of collapse, then there was insensibility, but then also in the warm bloods the

[1] Continued from p. 291.

life had ceased. Thus it was shown that nitrite of amyl was not an anæsthetic. It did not produce sleep.

After the life of the animals of warm blood was suddenly extinguished by the vapour,—and apparently the extinction was without pain,—I remarked that the internal organs of the body after the death were in some instances exceedingly congested with blood. The lungs and the brain were commonly in this state; but it struck me, though I could not explain the fact at the moment, that exceptionally these organs, when the death of the animal was instantaneous, were left quite bloodless, and actually white in their texture. Further, I observed that in the warm bloods the muscular irritability remained for a very long time after death, often for many hours. These phenomena were strange on the warm-blooded animals, but they were trifling in comparison with what was observed on cold-blooded animals. I discovered that in the frog the complete insensibility, and, as it seemed, absolute death, produced by the nitrite was not death really, but a suspended animation, a condition like that which has been called trance in the human subject. A condition of simulated death so perfect that no sign of life could be obtained, and yet from which, after so long an interval of time as nine days, the animal would wake up and enter again into life as if nothing had been done to derange its life. During all this time the limbs of the animal remained mobile; not a muscle was stiffened into the rigidity of death. There was induced, in fact, not only the trance of the human subject, but the corresponding cataleptic state of the muscular fibre. In addition I learned that during this state of suspense of life, the blood, though it was darkened and deprived of its capacity of becoming oxidised, and otherwise changed, was held in the fluid state. Like the muscles, it remained free of the change called pectous; it did not coagulate.

The next step in the investigation had relation to the action of the nitrite on the vessels which constitute the minute circulation. The change in the circulation in the web of the frog under its influence was carefully investigated; the condition of the circulation through the semi-transparent ear of the rabbit while the animal was breathing the vapour was also carefully investigated. The result of these inquiries was to discover that nitrite of amyl exerts a direct action on the nervous function, and that the action consists of a paralysing influence on the nervous mechanism by which the minute arterial system is controlled and governed. To repeat the words of the report I made to the meeting at Newcastle, "the action of the nitrite was directly on the nervous system, and that such action, transferred to the filaments of nerves surrounding the arteries, paralysed the vaso nerves, on which the heart immediately injected the vessels, causing the peculiar redness of the skin and the other phenomena that have been narrated."

In this preliminary inquiry I advanced the new propositions that we had in our possession a chemical substance which, being introduced into the body, overcomes the arterial tonicity, and causes phenomena analogous to those changes in the vascular current which follow upon division of the sympathetic nerve.

I further suggested that in cases of trance and catalepsy in the human subject, some substance analogous in its action to the nitrite is produced in the body by some error of secretion, some modification of the animal chemistry, and that the foreign substance so engendered is the cause of the disease. The first of these propositions is, I consider, proven; the second is not proven by any new research, but is still the most reasonable exposition of the phenomena to which it refers.

In continuation of experiment on the action of the nitrite of amyl on the nervous system, I studied next its local action, and came to the conclusion that its action on the nervous matter is not through the blood, but by direct impression through the nervous cords to the vascular motor nervous supply. I compared other bodies of the nitrite order—such as nitrite of methyl, ethyl, and butyl—with it in their operation. I compared it in its action with emotional shocks, and correlated the blush on the cheek or the pallor of the cheek which it produces with the blush or pallor induced by the impressions creating shame, fear, or other similar passions. I traced, through the whole of the phenomena induced by the agent, the action of the base amyl, and the effect of the addition of the elements, nitrogen and oxygen; and I showed that when oxygen and nitrogen are brought into combination with the base, the physiological effect is modified and the specific influence of the substance on the vascular system is declared. I was led to compare the action of nitrite of amyl with other chemical bodies, and, using it as a key, was enabled to show the analogical action of many other compounds. Notably, I pointed out from the observations collected during this inquiry, that alcohol produces its influence on the extreme vascular system by the same paralysing process. By investigating the effect of the agent after its long-continued inhalation, I was able to show that it induces changes in the circulation of the lung which lead to congestions and even to hæmorrhages like those which occur in some forms of pulmonary consumption, and thus the nervous origin of consumption of the lungs was brought fairly under notice as a new element of study in the clinical history of that fatal disease. In yet another series of observations I learned that rabbits afflicted with a singularly loath some skin disease—resembling *lepra* in man—recover rapidly in an atmosphere containing the nitrite vapour; that the dry and colourless and scaly skin of the animals become suffused with blood; that with this increased capillary circulation the scales fall off and healthy skin begins to appear; that the fur of the animals begins to grow; that the general nutrition of the animals is soon improved, and that within a month their cure is completed.

From my point of view the disclosure of these facts alone were a sufficient vindication of the line of research by experiment on living animals pursued with the nitrite of amyl. They were, however, very poor indeed, when they are compared with another disclosure of fact which came out of the same experimental research.

In 1863 I had learned that the influence of the nitrite of amyl was on the nervous vascular supply, that it paralysed temporarily the nervous action, and that the vascular redness it induces is due to this paralysis. In the succeeding year I followed up this subject more closely, and by an extension of observation I was led to the conclusion that in the nitrite of amyl we had found the most potent chemical agent that had ever been discovered for overcoming muscular spasm generally. The singular cataleptic and passive state of the voluntary muscles was an evidence of this fact, and it tallied with the earlier observation of the effect on the vascular tension. In addition, I saw that in this nitrite I held a substance which would not fix itself with the tissues of the animal and require to be eliminated by the slow process of fluid excretion through the kidney or skin, but that, owing to its insolubility and volatility, it would escape by the organs of respiration as well as by the other channels of elimination. I had learned, indeed, that in animals like frogs, from the bodies of which, owing to the thickness of the cutaneous tissue, the transpiration is easy, the spontaneous evaporation of the nitrite, extending over the long period of nine days, was sufficient of itself to lead to restoration of vital function. The study of the whole series of facts, when the facts were carefully collected and weighed, led to the demonstration that the original view as to the nitrite of amyl being a stimulant and an extreme excitant was wrong; it disclosed that the phenomena of excitation, as they at first seemed, were phenomena really of suppressed nervous function, that the vascular injec-

tion meant loss of vascular resistance, and that the supposed stimulant was indeed a paralyser of the most active kind.

In turn this reading of the true physiological action of the nitrite of amyl led me safely to its true therapeutical value, and the result was that its exact place in therapeutics was fixed correctly before ever it was used for the treatment and cure of disease. At the meeting of the British Association for the Advancement of Science held at Bath in 1864, I pointed out its therapeutical position. The application of nitrite of amyl as a new remedy for the use of the physician was clear: it was a remedy to be applied in controlling muscular spasm. It was, I said, selecting for my illustration the most terrible and typical of all the spasmodic diseases, it was the remedy even for tetanus or lockjaw, and this view I afterwards demonstrated by the direct experiment of neutralising strychnine tetanus in the frog by the application of the nitrite, of suspending the tetanic symptoms by the agent until the strychnine was eliminated, and of physiologically curing a disease which had been physiologically produced and which, but for the antidote, would have been irrevocably fatal.

So soon as the therapeutical position of nitrite of amyl had been discovered by experiment the practical adaptation of it was comparatively easy. I had only to learn how it had best be administered; how to administer it, by inhalation, by the mouth, by subcutaneous injection; how to make it combine with other medicinal substances, and how to select the most suitable substances with which to join it in combination. The researches in these directions were all conducted on human animals, or rather on one animal—the experimentator himself. The modes of administration were also recorded for the guidance of practitioners, and the remedy was in time fairly launched on a true scientific basis, its action explained, its use described, its effects predicated.

I spent three years in research on the physiological properties of nitrite of amyl in order to discover its place as a means of cure of human maladies. If I had spent thirty years instead of three the time and labour had not been badly repaid. The practical results of my work in the benefit conferred on mankind in mitigation of suffering and in cure of diseases of an intractable nature have been rapid in their course beyond expectation. Dr. Lauder Brunton first tried the application of the nitrite of amyl for the relief of one of the most acutely painful of the spasmodic diseases, the disease known as angina pectoris, and gained an immediate success. Dr. Anstie came to me for the remedy in a case where a man was in the pangs of death from acute spasmodic asthma, and after five minutes of the inhalation of the vapour found his patient breathing with the most perfect freedom, or, as he expressed it to me, "the man became conscious and natural in a few seconds so soon as the physiological action of the remedy took effect; it was like dragging a drowning man out of the water." Dr. Farquharson administered the vapour to a man in excruciating agony from colic, and witnessed the same relief so soon as the physiological effect was produced.

A little later came the application of the nitrite of amyl for the treatment of tetanus, the crucial trial of the agent which I had originally proposed. Mr. Foster, of Huntingdon, was the first surgeon to put it to the test in this disease. A man, after an injury, was seized with tetanus. In the spasmodic grasp of the malady he "was rolled up like a ball." Under the inhalation of the vapour of the nitrite of amyl his muscles relaxed, and whenever the spasm threatened to recur the administration of the vapour of the paralysing agent relaxed the contraction. So for nine days, during which an ounce of the remedy was given by inhalation, the death from the spasm was prevented; by that holding on, the cause of the spasm became inactive, as I had anticipated, and the recovery was secured.

Two other equally successful instances of this same kind have been recorded, and recently Dr. Fowler, of New York, has published a fourth experience identical in character, but with a remarkable additional fact appended. The sufferer who was, as we should once have said, fatally stricken with tetanus, made a primary recovery under the administration of the nitrite of amyl. Unfortunately the supply of the remedy ran out, and before a new supply could be obtained the tetanic spasms returned and continued with increasing violence. At last the remedy was reobtained, and after a lapse of sixty hours was re-administered. The relaxation of the tetanus was again secured, the return of the spasm was controlled over a period of several days, and once more the art of the physiologist was rewarded in the recovery of that stricken patient from one of the most terribly excruciating forms of painful death.

I have put no word of my own experience on the use of nitrite of amyl, long and successful though it has been, on the present record. I have supplied but a few typical facts from the experiences of other observers, and if I could put in all it would be but the record of the uses of a remedy which is as yet but beginning to be applied for the cure of painful diseases not only of men, but of lower animals also, especially of dogs and horses. The point I want to keep in mind is that the results already obtained are the fruits of experimental inquiry. I stood at the gate of the place where this new remedy came from. I took it first as a physician, from the hand of the chemist. I determined its place in medicine. Then other men took it from me, and confirmed my estimate. Thus the history of this remedy is made clear from its beginning, and it is most just to say that if I or some one else, given to like method of research by experiment, had not tested the agent in the same way, the results that have already been obtained from it had been lost. Whether the results are worthy the method—whether, for instance, the experiment of producing and curing tetanus in a frog is warrantable in order to discover a plan by which tetanus induced in man by natural disease can be cured by art these are the serious kind of questions on which opinion is now divided. It is my duty to show the practical arguments in favour of the experimentation.

BENJAMIN W. RICHARDSON

(*To be continued.*)

NOTES

On Friday last, in the House of Commons, Mr. Reed asked whether the memorial, already printed in our columns, signed by many of the most eminent men of science in the kingdom in favour of the establishment of a permanent Museum of Science had been presented to the Lord President of the Council; if so, whether he had any objection to laying it upon the table of the House; and whether the Government propose to take any action in the matter.—Lord Sandon in reply stated that he was glad the hon. gentleman had called attention to the important memorial to the Lord President of the Council, which had been signed by, he might almost say, all the most eminent men of science in the kingdom, in favour of the establishment of a permanent Museum of Science at South Kensington. He added that it was one of the many gratifying results of the remarkable exhibition of scientific apparatus which we have had the satisfaction of getting together at South Kensington, with the assistance of the leading men of science both of this country and of almost every civilised State. Lord Sandon promised to at once lay the paper on the table of the House. He was not in a position to say what action will be taken respecting it, but assured the hon. gentleman that it was receiving the best consideration of Her Majesty's Government.

A MOVEMENT at last has been made by Lord Aberdare, late Lord President of the Council, to obtain statistics relating to Secondary Education. On the 4th he asked the Duke of Richmond, the present Lord President, whether he had the means of making a return of the number of schools in England and Wales in which instruction was given to children above thirteen years of age, and if he had not, whether he would take any measure to supply such deficiency. There had been exhaustive inquiry into the universities, public schools, and elementary schools, followed by legislative action, but there had been no inquiry into the state of the schools—such as the endowed schools throughout the country · which occupied a position between the elementary and higher-class schools, and he believed that on inquiry it would be found that large districts were insufficiently supplied with the means of obtaining such education. He knew it would be impossible for the Lord President, however well disposed, to furnish the same amount of information on this subject which would be supplied through the medium of a Royal Commission. We certainly want not only these statistics, but town and country organisations, which are impossible without them.

No occasion has before drawn together so many distinguished men of science from abroad, in various departments, as the Centennial Exhibitition at Philadelphia. Without attempting to enumerate all who might be mentioned in this relation, *Silliman's Journal* recalls, from Great Britain, Sir William Thomson, the well-known physicist, who is President of the Judges on the XXVth Group—Instruments of Precision and Research; Sir John Hawkshaw, the eminent engineer who was last year President of the British Association; Sir Charles Reed, President of the XXVIIIth Group of Judges—for Education and Science; Capt. Douglas Galton, President of the Judges under the XVIIIth Group—Railway Plans, &c.; Mr. Isaac Lowthian Bell, the most eminent iron metallurgist in Great Britain, and author of the well-known treatise on the "Chemistry of the Blast Furnace," President of the Judges of Group I.—Minerals, Mining, Metallurgy, &c.; Dr. William Odling, Waynflete Professor of Chemistry in the University of Oxford, Secretary of the Board of Judges on Group III -Chemistry and Pharmacy, &c.; from Sweden, Prof. Adolf E. Nordenskjöld, Prof. C. A. Angstrom, Polytechnic Institute, Prof. O. M. Torrell, Chief of the Geological Survey of Sweden, and Richard Akerman, of the Royal Swedish School of Mines, all from Stockholm, under whose immediate superintendence the excellent geological, mineralogical, and metallurgical display of Sweden, at the Exposition, has been made; from Russia, Major-General Axel Gadoline, an eminent Russian engineer, and Prof. L. Nicholsky, Mining Engineer and adjunct Professor at the Mining School of St. Petersburg, who is in charge of a systematic collection of Russian minerals—the only systematic mineral collection in the Exposition; from Germany, Dr. Wedding, Royal Prussian Counsellor of Mines, Dr. Rudolph von Wagner, the well-known editor of *Wagner's Jahresbericht*, and Dr. G. Seelhorst, of Nuremberg; from France, M. L. Simonin, J. F. Kuhlman (fils), M. E. Levasseur, and M. Emile Guimet, of Lyons; from Italy, Prof. Emanuel Paterno, of Palermo; from Mexico, Mariano Barcena, the mineralogist. The Emperor of Brazil, without claiming the position of a man of science, manifests the most intelligent and cultivated understanding of all that is most worthy of notice in scientific methods, his inquiries extending to everything which should interest the head of a great Continental empire. Prof. Nordenskjold, on July 1, left on his return to join a new expedition of discovery to the seas of Northern Siberia.

THE number of statues erected by the French to their men of science is fast enlarging. Lately we had to mention the inauguration of M. Elie de Beaumont's monument in Normandy. We learn from the papers of Dauphiné (in the south-east corner) that Grenoble has just rendered the same honour to the celebrated Vaucanson, one of the greatest mechanicians of the last century. It was he who invented the chain for communicating motion at a distance. He used it with an admirable sagacity for constructing the first spinning machine and automata. Vaucanson's automata were deemed a century ago a wonder of the age. He was a candidate for admission to the Academy of Sciences, but was rejected by the influence of the Court party, to whom he was obnoxious. Louis XV. was highly pleased with the result of the election, and he was heard saying, "We will ask him to construct for us an automaton Academician." It was Vaucanson's own collection which formed originally the primitive stock out of which the Conservatoire des Arts et Métiers was grounded.

THE number of visitors to the Loan Collection of Scientific Apparatus during the week ending August 12 was as follows:—Monday, 8,991, Tuesday, 3,458; Wednesday, 424; Thursday, 388; Friday, 359; Saturday, 3,372; total, 16,992.

A NEW geological map of Scotland by Prof. Geikie, Director of the Geological Survey of Scotland, is about to be published by Messrs. W. and A. K. Johnston. It is on the scale of ten miles to one inch, like the tourist map which the same firm published some years ago, and which has been found so useful by all travellers in Scotland. The new map has been engraved with special reference to the requirements of the geologist. It is not too crowded with names, and instead of the old meaningless hill-shading, it has the heights marked by small triangles and reference figures. The geological information includes the most recent observations. The chief lines of dislocation are marked in strong black lines; the general dip of the formations is shown by arrows. In addition to the older rocks, the map shows the position of the more important raised beaches, river alluvia, tracts of blown sand and glacier-moraines. Round the edge of the sheet a series of sections has been engraved to illustrate the geological structure of each great division of the country. We understand that the map is to be ready for the meeting of the British Association next month in Glasgow, and therefore in time for the geological tourists, who will, no doubt, spread themselves over Scotland at the close of the meeting.

WE learn from the *New York Tribune* that Prof. Henry took the opportunity at the last meeting of the National Academy of Sciences, to say a few words about the Smithsonian Institution. Its funds at present, having been increased by donations and judicious management, amount to $717,000, although $600,000 has been expended on the building, and the original legacy produced only $541,000. Congress has enacted several liberal measures which have been of great service to the Institution and have relieved it of many expenses, such as the cost of caring for the grounds and library; and latterly an appropriation of $20,000 per year has cleared the expense of the National Museum. This liberality has enabled the Smithsonian to devote a larger share of its income towards publishing works of original research, and to defray the expense of its system of scientific exchanges, which has the whole world for its field. The publications already issued and under way were enumerated. Prof. Henry said that it was contemplated to authorise a series of experiments to determine accurately the rate of increase of the earth's temperature at progressive depths. This was now rendered more practicable than before by the number of artesian wells in the country. Another project included new and careful experiments on the velocity of light; that furnishing one of the means for ascertaining the distance of the sun. Some steps had been taken to carry out this project, and a gentleman had promised to give a special fund for the purpose. The work of obtaining accurately the

weight of the earth by the method devised by Cavendish would also probably be undertaken anew, there being at the present day better means for this purpose than those of the old experiments. Prof. Henry alluded to his own advancing years and his anxiety to have the Smithsonian in a position of permanent security before the close of his life. The accumulations of the museum already overstock the building, and when the collections that have been sent to Philadelphia are returned there will be no room for them. Conversing on the subject with a prominent member of Congress, he had recently stated his firm conviction that the problem could best be solved by abandoning the present building to the National Museum and erecting a new structure, to cost $100,000. The new building could be adapted solely to the needs of the Smithsonian in its proper work, and should contain besides accommodation for the system of exchange, a chemical, a physical, and a biological laboratory with a lecture-room.

MESSRS. WILLIAMS AND NORGATE have sent us the following new foreign publications:—"Die Dynamite, ihre Eigenschaften und Gebrauchsweise sowie ihre Anwendung in der Landwirthschaft und im Forstwesen," by Isidor Trauzl (Berlin, Wiegand and Co.); "Die Leitungsbahnen in Gehirn und Rückenmark des Menschen, auf Grund Entwickelungsgeschichtlicher Untersuchungen," by Dr. Paul Flechsig (Leipzig, Engelmann); "Studien uber die ersten Entwickelungsvorgange der Eizelle die Zelltheilung und die Conjugation der Infusorien," by O. Butschli (Frankfurt, Ch. Winter).

IN a reference to Bessels' *Protobathybius*, in NATURE, vol. xiv., p. 238, the statement is made that it has not been described and figured. This, it would appear, is erroneous, for Mr. A. S. Packard, jun., of Salem, Mass., has published a drawing and brief description of it, furnished to him by Dr. Bessels, in his little work entitled "Life Histories of Animals, including Man," which appeared a few months since.

THE following is the title of the essay to which the Howard medal of the Statistical Society will be awarded in Nov. 1877 (the essays to be sent in on or before June 30, 1877). "On the condition and Management—past and present—of the Workhouses and similar Pauper Institutions in England and Wales, and their effect on the Health, Intelligence, and Morals of the Inmates." Further particulars at the rooms of the Society in Somerset House Terrace, Strand, W.C.

MR. CHARLES DARWIN has been elected an Honorary Vice-President of the Birmingham Natural History Society.

WITH regard to the statement in our recent paper on Oyster Fisheries, that some fix three, others four, years as the age at which an oyster becomes reproductive, Mr. W. Fell Woods, a Director of the South of England Oyster Company, writes us that it has been known to many that oysters breed when two years old, and in the course of his own investigations (as stated in his evidence before the Select Committee), he had found them to spat when twelve months and *even barely* twelve months old. The conditions then have, no doubt, been somewhat exceptional, whilst at two years it is comparatively frequent.

THE Abstracts of Meteorological Observations made in New Zealand during 1875 have come to hand. They show for fourteen places the monthly results of pressure, temperature, humidity, rain, wind, and cloud, compared with previous years' averages, together with notes descriptive of the general character of the weather and the unusual phenomena at each station, and a rapid and graphic summary for the whole of New Zealand, the earthquakes being specially recorded. The publication might be made still more valuable if pressures were given not reduced to sea-level, if the methods of computing the different averages were clearly stated, and if some of the more important results were also published for different hours.

IN the June number of the *American Journal of Science and Arts*, there appears a short article on "The Curve of Eccentricity of the Earth's Orbit," by Mr. R. W. McFarland, of the Ohio Agricultural and Mechanical College, Columbus. Mr. McFarland has performed the self-imposed task—one of great labour—of testing the accuracy of the tables given by Mr. Croll and by Mr. Stockwell. Mr. Croll, it will be remembered, computed the values by Le Verrier's formulæ, and Mr. Stockwell by formulæ of his own. Mr. McFarland has now re computed the values by Le Verrier's formulæ, and finds "Croll's figures correct in most cases, and not in error to the amount of ·001, except in one instance."

THE operations of the United States Fish Commission in the way of stocking the Connecticut and other rivers of the United States with shad, promise to be very successful during the present season, unless the great heat should bring up the temperature of the water to such a degree as to interfere with the proper hatching of the eggs. More than a million and a half of eggs were taken during the first week of the work, and a large number of the fish therefrom were placed in the river at Bellows Falls. As the hatching establishment is below the Holyoke Dam, the fish are introduced above it, so that in their return from the sea they may proceed up the fish-way to their starting-point, instead of remaining below it, as would otherwise be the case.

IT appears from reports brought from Iceland and the north by Capt. Ambrosen, of the *Arcturus*, that boisterous weather has been experienced within the whole navigable portion of the Arctic circle, the high winds driving the field-ice southward in large quantities. It is thence inferred that the ice within the polar basin has been broken up to a larger extent than usual, thus probably favouring the Arctic Expedition in carrying out its objects.

THE ninth annual report of the trustees of the Peabody Museum of American Archæology and Ethnology, presented in April of the present year, has been published, and gives an account of the additions to this extremely extensive and important collection. Since the death of the lamented Prof. Jeffries Wyman, the museum has been under the charge of Prof. F. W. Putnam, who has continued the cataloguing and arrangement begun by his predecessor, and brought the whole establishment to a condition of thorough efficiency. Many valuable additions are recorded during the year, the most important, and, indeed, the largest donation ever made to the museum, being that from Peru and Bolivia, collected at the expense of Mr. Alexander Agassiz, and presented by him, embracing nearly six hundred specimens. These consist largely of objects from the ancient burial-places at Anton, Chancay, Pasagua, Pacasmayo, and the island of Titicaca. The total number of additions to the museum amounts to over eleven hundred specimens. The report as published contains a general index to the nine annual reports of the museum, which are arranged to form volume one of the collective series. It is accompanied by portraits of Mr. George Peabody and Prof. Wyman.

THE additions to the Zoological Society's Gardens during the past week include a Grizzly Bear (*Ursus ferox*) from California, two Black Iguanas (*Metopoceros cornutus*) from San Domingo, purchased; two Booted Eagles (*Aquila pennata*), three Common Bustards (*Otis tarda*) European, a Leopard Tortoise (*Testudo pardalis*) from Port Elizabeth, deposited; five Gold Pheasants (*Thaumalea picta*), an Amherst Pheasant (*Thaumalea amherstiæ*), a Siamese Pheasant (*Euplocamus prælatus*), a Crested Pigeon (*Ocyphaps lophotes*), a Porto Rico Pigeon (*Columba corensis*), bred in the gardens.

SOCIETIES AND ACADEMIES

GENEVA

Physical and Natural History Society, March 2.—M. Casimir de Candolle gave the result of his researches on the movements of the leaves of *Dionæa muscipula*, undertaken for the purpose of ascertaining if the anatomical constitution of these leaves furnished a sufficient explanation of these movements. His investigation has confirmed this hypothesis and has proved to him that the movements referred to, as well as those of the sensitive, for instance, are the result of the turgescence of the tissues and not of electric currents or other causes. The leaf of Dionæa is composed of two essential parts; one part petiolary, and at the extremity of that a limb or circular leaf, whose two halves are movable around the central nerve. Each of these two valves carries three hairs, which it is sufficient to touch very gently, with a human hair for example, to cause the valves to close. Having investigated the internal structure of these valves, M. de Candolle has found that they are composed of two different kinds of tissues. The upper layer is composed of parenchymatous cells, relatively young and yet turgescent; the inferior layer of cells much older, which are no longer turgescent. At a given moment, and in consequence of the shock communicated to the upper layer, the water which it contained is expelled, a contraction is produced, and the leaf closes. All the arrangements of the leaf and especially that of the secondary nerves, which are perpendicular to the great nerve, contribute to bring about this maximum movement. The gradual development of these leaves is in favour of this theory; the valves of all the young leaves are at first rolled up and they are stretched out at the moment of complete expansion. The leaf does not close if one simply touches the leaf; it is necessary to touch one of the hairs. Their anatomical structure was then examined and M de Candolle found that they are composed of very elongated cells, forming a rigid cone, which rests on an articulation formed by two great cells, round which it turns very easily. The least shock communicated to this long arm of the lever, is transmitted with great readiness to the internal layers of the leaf, and develops the phenomenon of turgescence, which is not produced when simply the epidermis of the leaf is touched. These hairs are not true hairs, but excrescences in intimate relation with the interior parenchyma; hence their energetic action in the internal portions of the leaf.

PARIS

Academy of Sciences, Aug. 7.—Vice-Admiral Paris in the chair. The following papers were read:—Experimental critique on glycæmia (continued), by M. Claude Bernard. He illustrates three statements:—1. Glycæmia does not differ in carnivorous and in herbivorous animals; it is independent of alimentation. 2. In traversing the arterial system the blood contains nearly the same proportion of sugar. 3. In the general venous system the proportion of sugar is variable, but always inferior to that of the arterial blood.—Observations of M. P. Thenard with reference to M. Bernard's communication. He calls attention to capillary affinity, and a mode he found of destroying it. He left a large vessel of gelatinous alumina in a chamber where it froze during winter. In spring he found the vessel filled with water, and, at the bottom, a thin layer of an alumina, which as to its capillary affinity, shared but little the properties of the frozen alumina. He has practised the method artificially in purification of his black acids. Now M. Bernard pours into a maximum solution of sulphate of soda an equal volume of blood. The blood coagulates, then by evaporation and cooling, crystallisation of the salt is effected. This crystallisation, the author points out, is virtually the same as his congelation.—On the alteration of urine; reply to Dr. Bastian, by M. Pasteur. He considers Dr. Bastian's reply as aside from the point in discussion. The difference is solely with regard to interpretation of the facts.—On the carpellary theory according to the Loaseæ (second part), by M. Trécul.—Reply to the last communication of M. Hirn, by M. Ledieu.—On radiometers of intensity, by M. de Fonvielle. The dissymmetry of action necessary to rotation may be obtained by substituting a dissymmetry of figure, relatively to the axis, for dissymmetry of substance or of coloration. The arrangement of feather mills might be imitated, or that of cup anemometers, or that of screws actuated by an air current, or that of the orreries turned by the current from a Holtz machine.—On a new process for preparing tinder wicks without poisonous substances, by M. Monier. Oxide of manganese is substituted for chromate of lead. The wicks are impregnated with sulphate of manganese, which is decomposed by caustic soda, or they are simply immersed in a solution of permanganate of potash.—On the phylloxerised spot (4 hectares) of Mancey (Saone-et-Loire), by M. Rommier. The facts show that in its progress northwards, the phylloxera is not prevented by the greater coolness of climate, and that application of sulphocarbonates to advanced spots at the proper time, may reduce the swarming, and save, for a long period, the neighbouring unattacked vineyards.—On determination of the carbonic acid contained in waters (of irrigation, of drainage, of springs, of rivers, &c.), by M. Houzeau. The method is to liberate successively, in the gaseous state, the free and the combined carbonic acid, and absorb by 5 cubic centimetres of a concentrated solution of soda with addition of $\frac{1}{100}$ of oxide of zinc. The carbonic acid is then estimated volumetrically by a method the author described in *Ann. de Chimie et de Physique*.—On a new process of qualitative testing and determination of potash, by M. Carnot. He uses the new reaction given by salts of potash in presence of hypo-sulphite of soda and a salt of bismuth in a charged solution of alcohol.—On the different rotatory powers possessed by sugar-cane according to the process employed for measuring them, by M. Calderon.—Process for determining hydrocarbons, and especially fire-damp in mines, by M. Coquillion. He composes a certain number of mixtures of air and protocarbonised hydrogen, introduces a given quantity of the mixture into a tube in which is soldered a palladium spiral, reddens the wire, awaits cooling, then measures the remaining gas. (Platinum wire gives frequent detonations in hydrocarbons with air, but palladium does not.) By comparison, the quantity of fire-damp in a given atmosphere may be estimated.—On the employment of chloride of calcium in watering of streets, promenades, and public gardens, by M. Cousté. He calls attention to his experiments on the subject, previous to those of M. Houzeau.—On some peculiarities of reflex movements produced by mechanical excitation of the cranial dura mater, by M. Rochefontaine. Such excitation on one side will cause contraction of one or of several muscles of the face on the same side, and for this a slight excitation suffices, or the animal may be but partly anæsthetised. A stronger mechanical stimulation causes also movement of the limbs on the same side, and a still stronger one movements of all four limbs. In the second case the excitation must be transmitted directly to the corresponding half of the chord; and in the third there is both direct and cross transmission; the direct being more intense, however, for the movements on the corresponding side are stronger.—Botanical affinities of the genus Neuropteris, by M. Renault.—On the annual revision of the magnetic map of France, by MM. Marié Davy, and Decroix. Table of declinations given. From June, 1875, to June, 1876, the mean annual variation of Paris was about $0° 2' 12''$.

CONTENTS

THURSDAY, AUGUST 24, 1876

EASTERN PERSIA

Eastern Persia. An Account of the Journeys of the Persian Boundary Commission. Published by the Authority of the Government of India. Two vols. (London: Macmillan and Co., 1876.)

IN the year 1837 a Treaty was concluded at Paris between the English and Persian Governments, under the provision of one of the articles of which it was arranged that the Shah should "refer for adjustment to the friendly offices of England" any differences that might occur "between Persia and Herat or Afghanistan."

During his Indian viceroyalty one of the questions which attracted the serious attention of Lord Mayo was that of the relations of Sistan, a province on the eastern frontier of Persia, which, though at the time properly belonging to Afghanistan, was being gradually encroached upon by its western neighbours. Both Governments appealed to England, and to settle the question at issue—the boundary-line—an arbitrator was appointed in the person of Sir Frederic J. (then Colonel) Goldsmid, who was at the time Director-in-Chief of the Government section of the Indo-European Telegraph. His instructions were, after he had decided the Sistan boundary, to proceed to Baluchistan and also settle the disputed frontier between that country and Persia, a point of special interest to ourselves, as it affects the facility of retaining in an efficient condition the telegraphic communication through Persian territory. Though this was the plan originally proposed, unexpected difficulties were the cause of its being considerably modified; the result was, however, the same in the long run.

Sir F. Goldsmid left this country on his special mission at the end of August, 1870, and had finally returned from it in the middle of September, 1872. He was accompanied by Major Euan Smith, his secretary, who, in the work under consideration, gives a most interesting and detailed account of both the Perso-Baluch Frontier Mission which was undertaken in 1870-71, and of the Perso-Afghan Mission of 1871-72.

The Introduction to the whole work is by Sir F. Goldsmid. In it the author briefly, but clearly, explains our relations with Baluchistan and Afghanistan, the internal government (or lack of government) in those countries, and the most important events of recent date in their history which bear upon, together with the steps which have been taken by this country to assist in, their consolidation.

Majors Oliver St. John and Lovett, of the Royal Engineers, and Major Euan Smith, of the Madras Army, are the authors of the first volume of the work. Major St. John, who had previously been employed in the Telegraph Department at Tehran, has a valuable chapter upon the Physical Geography of Persia, followed by an account of his journey with Mr. Blanford through Baluchistan and Southern Persia, undertaken with the object of further investigating the topography of the district through which Sir F. Goldsmid had been compelled from various reasons to fix the Perso-Baluch boundary rather precipitately. Major St John gives three maps of Persia in association with his valuable account of the nature of the country—the first hydrographical, the second orographical, and the last showing the routes of the different members of the mission.

Major Beresford Lovett, who accompanied the Arbitrator during both his missions, and performed the preliminary survey of the Makran region, gives a narrative of his journey in Baluchistan, laying special stress on those places not referred to by Major St. John.

Major C. B. Euan Smith, as above mentioned, describes the journeys performed by Sir F. Goldsmid and himself, undertaken with the object of deciding the Perso-Baluch and Perso-Afghan boundaries. His narrative possesses all the interest which is inherent in the accounts of the habits and customs of people not well known by most of us, as told by an able and observant traveller.

The second volume is devoted to Mr. Blanford's account of the zoology and geology of Persia. Mr. Blanford's great experience as a field naturalist both in India and Abyssinia enabled him to undertake the study of the fauna of Persia with a feeling of confidence that he would do justice to the subject which few others could have possessed, and we are sure that all who carefully peruse the work before us will fully appreciate the advantages which have accrued to biological science from his efforts. Besides his own collection, Mr. Blanford has had the opportunity of studying that made by Major St. John between the years 1869-71, whilst he was employed in superintending the construction of the telegraph line through Persia.

To the information given us by Gmelin, Pallas, De Filippi, and others on the fauna of Persia, Mr. Blanford greatly adds. His brief *résumé* of the physical geography of the country, fully described by Major St. John in the first volume of the book, gives an excellent idea of the region. "The country consists of a number of desert plains, at various elevations of from about 1,000 to 5,000 feet above the sea, separated from each other, from the lower country to the east, north, and west, and from the coast to the south, by ranges of mountains varying much in height and breadth, but often of considerable elevation. The Persian plateaux, or highlands, consist of plains and ranges of hills, for the most part destitute of vegetation, agriculture being only possible where water can be obtained from springs or the small streams which descend from the higher ranges to lose themselves in the various deserts of the interior. Along the southern coast of the Caspian Sea is a damp region covered with dense forest, and the western slopes of the Zagros Mountains are also wooded, though less thickly, than the northern slopes of the Elburz. The Zagros belt of woodland extends south to the neighbourhood of Shiraz, where, from the prevalence of a species of oak, the tract is often spoken of as the Oak Forest. This tract is crossed on the road from Shiraz to Bushire, but it does not extend much farther to the south-east. There are, however, in the broken country, extending along the shores of the Persian Gulf and Indian Ocean, and forming part of Fars, Laristan, and Baluchistan, a few plains and valleys which support a rather thin forest, the trees being different from those of the Zagros and Shiraz forests, and consisting chiefly of tropical forms, among which tamarisk and mimosa are conspicuous. These comparatively fertile tracts are however seldom met with, the greater part of the country being as barren as the Persian highlands."

On account of the differences in the physical condition of the country above indicated, its fauna correspondingly varies; and, according to Mr. Blanford, five zoological sub-regions may be defined with tolerable accuracy. Each of these deserves brief reference upon the present occasion. The first is that of the Persian plateau or highland, which forms by far the greatest and most characteristic part of the country. Although this district, and all the others except the last, are Palæarctic in their nature, nevertheless several types characteristic of the desert tracts of North Africa and Central Asia are included, such as the genera *Gazella*, *Gerbillus*, *Dipus*, *Gyps*, and *Buteo*.

The second sub-region is that of the Caspian provinces Ghilan and Mazandaran, which form the forest-covered, humid southern shore of the Caspian Sea. The fauna is almost identical with that of South-east Europe. The tiger is found there, however, and a Deer (*Cervus caspius*) closely allied to the Axis Deer of India, as well as a Pit-viper (*Halys*).

The third sub-region is that of the wooded slopes of the Zagros, running from Shiraz, as a strip, in a north-westerly direction. It differs, as far as is known of it, but little from the last, with which it may be confluent. The lion inhabits it, as well as a new species of Woodpecker (*Picus sancti-johannis*). The fourth sub-region is that of Persian Mesopotamia, which is the eastern portion of the Tigris plain. It closely resembles Syria in fauna. The last is that of Baluchistan and the shores of the Persian Gulf, which differs greatly from the rest of Persia, Indian or Indo-African forms prevailing.

Mr. Blanford enumerates eighty-nine species of mammals, three hundred and eighty-three of birds, ninety two of reptiles, and nine of amphibia, as found in Persia; and he mentions as a general characteristic of the fauna, that the specimens are paler in colour than their European allies. This paleness frequently makes it difficult to decide whether the species are new or only varieties of those already known. In some cases, however, as, for instance, that of the Persian Badger, the author tells us that he would not have proposed a new name for it had not the skull, when compared with a series of skulls of *M. taxus*, presented decided differences.

The number of fresh species determined by Mr. Blanford and others from the collection made by Major St. John round Shiraz between 1869 and 1871, and by both these naturalists in their journey through Baluchistan and Southern Persia, is too large to be enumerated here. Of new genera Mr. Dobson determined the Phyllorrhine Bat (*Triaenops persicus*), with its very complicated nose-leaf and peculiar third alar digit, in 1872; and Mr. Blanford has, from an exhaustive study of the reptiles, made the genera *Bunopus*, *Ceramodactylus*, *Agamura*, and *Zygnopsis*. Curiously, no crocodiles are known to occur in the country, though they are common in the neighbourhood of Sind, and are to be found in Palestine; their absence is associated with the inconstancy of the supply of water in the small rivers. The Agamoids and Lacertians are much more abundant than the Geckos and Scincids.

Of the placental mammals the Quadrumana, Proboscidea, Hyracoidea, and Edentata, are the orders which are not represented in Persia. Bats are not numerous, as far as species are concerned. Of Insectivores another species of hedgehog is described and figured. *Vulpes persicus* is the name given to a fresh Fox, and *Meles canescens* to the Pale Badger above mentioned. Among the Rodentia several new species have been discovered, including a squirrel, a dormouse, a mouse, two jumping-rabbits, a jerboa, and a hare. No specimen of the male of the new *Gazella fuscifrons* was obtained, although Major St. John, in his narrative, tells us that he lost the only one he saw from his cartridge missing fire.

Of new birds we find a Woodpecker (*Picus sancti-johannis*), a Robin (*Erythacus hyrcanus*), a Warbler (*Sylvia rubescens*), a Sun-bird (*Nectarinia brevirostris*), a Nuthatch (*Sitta rupicola*), a Tit (*Parus phaeonotus*), as well as a second (*P. persicus*), and a Jay (*Garrulus hyrcanus*). Besides the new genera of reptiles above mentioned, there are many fresh species, the descriptions of all of which, as of the mammals and birds, are accompanied by excellent figures from the pencil of Mr. Keulemanns or the late Mr. G. H. Ford, whose recent death will be felt as a great loss to naturalists generally and students of the Reptilia especially, because of the extreme care which he was always accustomed to take in the accurate delineation of the most minute detail.

What will strike the readers of the work before us most forcibly is the great pains which Mr. Blanford has taken in the accurate determination of the species he describes, and the trouble he has put himself to—by a reference to the original types—in whatever part of Europe they may be to insure their correct identification. In many cases he has been able to give his measurements from unskinned specimens, and in several instances among the birds he has recorded the essential lengths of a large number of specimens. As an instance of this may be taken the case of *Hypolais pallida* and its allies, in which a lengthy series of measurements is given to show the complete gradation between that species, *H. rama* and *H. caligata*, forms whose specific identity is based upon slight differences in size only.

In the geological section of the volume no complete account of the geology of Persia is attempted, but Mr. Blanford adds his own experience to that of Messrs. Loftus, Bell, Grewingk, Carter, and others.

In concluding this brief notice of the valuable work before us, we feel that it is only by a detailed perusal of its contents that its value in a geographical, zoological, geological, and political point of view can be fully appreciated.

SUMNER'S "METHOD AT SEA"

Tables for Facilitating Sumner's Method at Sea. By Sir William Thomson, D.C.L., LL.D., F.R.S., Professor of Natural Philosophy in the University of Glasgow, and Fellow of St. Peter's College, Cambridge. (London: Taylor and Francis, 1876.)

THE reforms which Sir William Thomson has effected or suggested in the art of navigation are neither few nor unimportant. His invention of deep-sea sounding by pianoforte wire, and his improvements in the construction of the mariner's compass, are specimens of what he has done in the instrumental part of the subject. In the book now before us he again comes forward as a

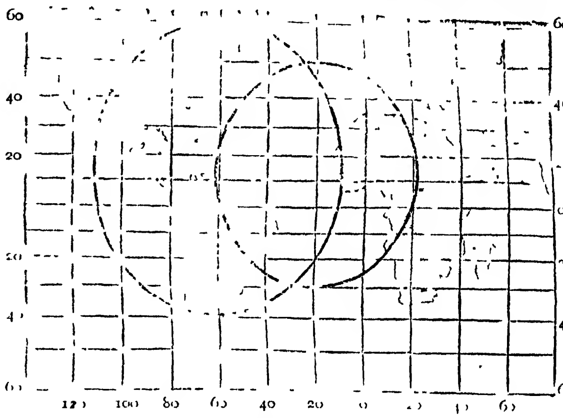
nautical reformer, this time in another section of the field, that, namely, which treats of the calculations following on the astronomical observations of the sun or stars, which form part of the daily routine work of every navigator. Innocent as the title of the book appears, the general adoption of the method which it advocates would amount to little short of a revolution in nautical practice—a revolution which is urgently needed, and which would unquestionably be of immense advantage to sailors in more ways than one.

When an observer takes the altitude of the sun or of a star at a known instant of Greenwich mean time, he learns two things. His knowledge of the time, when brought to bear upon the information which he finds in his nautical almanac, tells him that the sun or star was vertically overhead at a certain known point on the earth's surface at the time of the sight. His knowledge of the altitude tells him that the ship was at the same time somewhere on an imaginary circle drawn on the earth's surface, the centre of which is the point where the sun or star was vertically overhead, and which lies at an angular distance from this centre (measured on the terrestrial globe) equal to the complement of the altitude. On what part of this imaginary line he is, his sight does not tell him, but he can easily make a guess to within sixty miles or so. If, then, he can draw a portion of this circle, short enough to be taken without sensible error as a straight line, in that part of his working chart in which he knows his ship to be, he will have obtained from his sight all the information which that one sight can give him, and no more. This is so very obvious, that it seems strange that no one should have pointed it out before 1843. Nevertheless, it appears to be the case that Capt. Thomas H. Sumner, of Boston, Mass., was the first to do so, and to publish a practical method of drawing the line we have spoken of. The circle on any part of which the ship may be is now commonly called a Sumner circle of equal altitude, for from every point in it the altitude of the body observed is the same at the time of the sight. The short straight portion of it which in practice is drawn on the working chart, is called a Sumner line.

To illustrate the drawing of Sumner circles we cannot, perhaps, do better than quote the example given in the preface to Sir William Thomson's book:—

"Suppose that the altitude of the sun's centre was observed to be 50° at 1h. 17m. 48s. P.M., Greenwich mean time, on the 27th August, 1874. From the *Nautical Almanac* we learn that the sun 'southed' at Greenwich at 11h. 57m. 48s. A.M. on that day, therefore at the instant of the observation he was due south of a place one hour and twenty minutes in time, or twenty degrees in angle west of Greenwich. His declination at the time of the sight was 10° N. Hence he was overhead in lat. 10° N., long. 20° W. If one point of a pair of compasses be put on this point on a globe representing the earth, and a circle be drawn by the other point running at 40° (that being the zenith distance or complement of the altitude) from this point, this circle will be such that at any point on its circumference the altitude of the sun was 50° at the instant of the observation. The chart given below shows this circle drawn on Mercator's projection, which, of course, draws out the north and south parts and prevents it from appearing like a true circle. The circle corresponding to the example just given is the eastmost one on the chart.

"Suppose now that 2h. 40m. later the altitude of the sun is again taken and found to be 40°. At the moment of this second observation the ship was somewhere on the other circle, the westmost of the two given on the chart. What we learn from the two observations, then, is



that at the time of the first observation the ship was somewhere on the circle to the right, and at the time of the second observation she was somewhere on the circle to the left. If, therefore, she did not change her place between the two observations, she must have been at one or other of the two points in which the circles intersect."

It is, of course, as impracticable as it is unnecessary to draw the whole of the Sumner circle corresponding to each observation. Sumner's method may be defined as any practical method by which the short straight portion called a Sumner line can be drawn. This may be done in either of two ways. Here, again, we may quote Sir W. Thomson:—

"Every part of the Sumner circle is perpendicular to the true bearing of the body observed, and therefore the azimuth of the body observed is equal to the angle which the Sumner line makes with the parallels of latitude. Hence, if we know the latitude and longitude of one point in the Sumner line, and also the true azimuth of the body observed, we are able to draw the line on the chart. This brings us to the consideration of practical methods of drawing the Sumner line for an observation. Let the latitude be estimated to (say) the nearest degree, and let the longitude be calculated corresponding to this latitude. This gives us the latitude and longitude of one point on the Sumner line. Next calculate the true azimuth of the body observed at the time of the sight. Then through the point draw a line making an angle with the parallels of latitude equal to the true azimuth, and so as to be perpendicular to the true bearing of the body. The line so drawn is the Sumner line, and all that any one sight tells us is that the ship is somewhere upon it.

"It is, however, more usual to calculate the longitude of two points on the Sumner line corresponding to two estimated latitudes, differing by half a degree or more, and then to draw on the chart the line passing through the two points so determined. This last is the plan given by Captain Sumner."

Each of these plans is a little tedious, for each involves two distinct calculations. But since the Sumner line is really the only true statement of what any sight tells, we might expect that, spite of its tediousness, Sumner's method would be found in general use. Unfortunately it is not so. The usual practice among sailors is not to work out every sight independently, but to complicate the conditions of the problem by the introduction of some new element in order to shorten the work of calculation. Sum-

ner's method gives, as we have seen, a line on which the ship is, and in doing so it gives us all the information which any one sight can yield. But if we possess some other information, such as a knowledge of the true latitude, the position becomes completely determinate; each condition gives a locus, and the intersection of the two loci gives a point By introducing this foreign element into the calculation of the original sight, we may obtain at once the definite information that the ship is in a certain latitude and longitude, and we may do so by a single calculation. This is the practice of ninety-nine navigators out of a hundred, but it is a practice much to be deprecated. It makes the sailor imagine that a knowledge of the latitude, got either by dead reckoning or by taking a meridian altitude, is necessary in order that he may get any information at all out of a single observation of altitude and time. If he trusts to obtaining this knowledge by dead reckoning he is likely enough to estimate the latitude wrongly, and by so doing to vitiate the whole calculation. If he trusts to observing the meridian altitude, he is often disappointed by the sun's being clouded over at noon. Many a captain has lost his ship through not knowing how to avail himself (by Sumner's method) of the information which he might have derived from a short glimpse of the sun on a cloudy day. Another danger in the ordinary practice is that it tempts the navigator not to work out each sight as soon as it has been taken, for he must often wait until he is able to obtain the other information, without which he is helpless. But when Sumner's method is used, every sight tells its own tale, and there is no reason whatever why it should not tell it at once.

The limits of a review do not admit of our describing the manner in which Sir William Thomson has contrived to facilitate Sumner's method. A full explanation of how it has been done will be found in the preface to his book. At first sight it appeared that, in order that tables might be of any use, they would require to contain the solutions of 157,464,000,000 spherical triangles, to calculate which, at the rate of 1,000 per day, would take 400,000 years. This did not seem promising, but Sir William Thomson was not dismayed. He soon saw that by dividing the problem into the solution of two right-angled spherical triangles he could give all the required information in a table containing the solutions of only 8,100 triangles. These 8,100 calculations have been made under the superintendence of Mr. E. Roberts, of the *Nautical Almanac* Office, and the results are tabulated in the volume before us. Full instructions for their use are appended, along with some auxiliary tables which add greatly to the completeness of the work. Not to go into details, we may say that by an admirable application of the *second* of the two plans given above for drawing the Sumner line, the author has so shortened the time required to reduce an observation, as to convert what was formerly an objection to Sumner's method into a positive recommendation, and so has deprived sailors of their only possible excuse for not adopting it universally.

Such a general adoption, besides its direct benefits in increasing the safety of ships and men at sea, could not fail to have a great indirect effect for good in assisting the sailor to a clear perception of the fundamental principles underlying the processes which he daily employs, too often, we fear, in blind routine. A seaman using Sumner's method can hardly help understanding what he is about, but he may work for a lifetime with the hackneyed formulæ in common use, and have no notion from first to last of why he should add a quantity rather than subtract it, or indeed of why he should deal with it at all. We have heard of a captain who used a *plus* instead of a *minus* sign for two or three weeks, and first suspected that something must be wrong when he found himself on a coral reef hundreds of miles off his supposed course. When a landsman with a smattering of mathematics goes to sea and is admitted to the privacy of the chart-room, his wonder is, not so much that some ships are lost, as that any ships escape.

It is not the masters or the mates that are chiefly to blame for this state of things. Before they enter the service their utmost immediate ambition is to get the needed certificate of competency from the Board of Trade, and they naturally study only to pass the required examination. Then afterwards their professional life is not exactly that calm repose which conduces to progress in a scientific knowledge of their art. There are no doubt exceptional men whose love of their profession is so strong as to override the barriers of circumstance. Such men deserve all praise, but we can hardly blame the rest. For a remedy we must look not to the individual officer but to the authorities who have the making of him. It is strange that the Board of Trade should not have seen it to be a duty to let no British seaman obtain its certificate without showing himself to be thoroughly acquainted with Sumner's method. Until the Board does this it will be mainly, we might say almost wholly, responsible for the prevailing neglect of this method.

The position of the nautical reformer seems to us to be anything but enviable. His virtue is perhaps its own reward, certainly he seldom meets with any other. The Board of Trade and the Admiralty will have none of him, and he cannot make much way against the conservatism bred of ignorance that he finds elsewhere. It is still fresh in the memory of every one how Mr. Plimsoll at last compelled a reluctant government to take legislative action on behalf of seamen. Unfortunately, Sir William Thomson must confine himself to milder methods: he has no opportunity of shaking his fist in the face of a prime minister.

OUR BOOK SHELF

Botanical Tables for the Use of Students. Compiled by Edward B. Aveling, B.Sc. Second Edition. (London: Hamilton, Adams, and Co.).

ANY attempt to compress the facts of nature within the arbitrary limits of a defined tabular statement must necessarily be misleading from a scientific, that is, from a philogenetic, point of view. Classificatory tables have nevertheless their use to the student, in aiding his memory by bringing a large number of facts within a small compass. Dr. Aveling is careful to disavow any independent value for his tables, and frankly states that they will not only be useless, but positively injurious, if allowed in any way to be a substitute for practical field-work. With these limitations the tables may be recommended as probably as good, or nearly so, as any that could be drawn up. They have been compiled carefully, and on the whole successfully. Defects can no doubt be pointed out. Thus the description of certain inflorescences as "centripetal arranged centrifugally" requires a foot-note to explain its

meaning; the class *Gymnospermæ* is given on one page as of superior value to *Incompletæ*, on another as included within it; and it is difficult to understand how the terms "loculicidal" and "septicidal" can be applied with propriety to a mono-carpellary capsule like that of the primrose. The statement that "the tables on classification have been compiled from Dr. Hooker's 'Student's Flora of the British Islands'" is rather misleading, when we find, on p. 14, the Gamopetalous orders with inferior ovary included in "Calyciflorae." But defects of this sort are incidental to any attempt of the kind. Dr. Aveling may be congratulated on the success of his effort, if it be not of a very high order.

Vergleichende Untersuchungen über den Bau der Vegetationsorgane der Monocotyledonen. Von Dr. P. Falkenberg. Mit drei Tafeln. (Stuttgart: F. Enke, 1876.)

OUR knowledge of the anatomical structure of the stem of Monocotyledons has hitherto been pretty much confined to that of palms, and has been founded to a great extent on the researches of Mohl and Mirbel. It has hence been assumed, perhaps somewhat rashly, that the type of structure is far more uniform in the stem of Monocotyledons than of Dicotyledons. For the purpose of investigating this point Dr. Falkenberg has submitted to very careful examination the stem of one or more species belonging to as many as seventeen orders or sub-orders of Monocotyledons, and shows that our previous conceptions must be modified in several respects. The stem of Monocotyledons, he states, is divided into an inner central cylinder and an outer cortical layer by a separating sheath which is developed in some cases from the internal, in other cases from the external tissue. As regards the course of the fibrovascular bundles in the central cylinder, and the degree to which they are differentiated from the fundamental tissue, he finds three different types of structure. Perhaps the most important correction of ideas previously accepted is his complete refutation of the statement found in so many text-books, that Monocotyledons have none but adventitious roots. Dr. Falkenberg asserts that the existence of a normal tap-root is general in Monocotyledons, with the exception of those that are altogether destitute of a root. The adventitious roots which subsequently, in many cases, supplant the original tap-root, do not differ from it in an anatomical point of view. A. W. B.

Jenkinson's Practical Guide to the Isle of Wight. By Henry Irwin Jenkinson, F.R.G.S., &c. Also Smaller Practical Guide. (London: Stanford, 1876.)

MR. JENKINSON, by his practical guides to the Lake District, Carlisle, and the Roman Wall, has already proved himself possessed of a rare faculty for the work of guide-book making. The handy volumes before us are quite equal to those previously published. The "Guide to the Isle of Wight" is evidently the result of conscientious work and minute painstaking; the author has gone over all the ground described, and made himself well acquainted with all the historical and antiquarian knowledge which adds interest to the various places referred to. The introduction to the larger "Guide," covering upwards of eighty pages, contains a *résumé* of the scientific knowledge which bears on the island—its geology, its flora, and its fauna. This part seems to us carefully and accurately compiled, and by the scientific visitor will be considered a valuable addition to the volume. Mr. Jenkinson divides the text of his "Guide" into six sections, grouped round the chief towns of the island, each section being accompanied by a full and clear and carefully executed map. Altogether Mr. Jenkinson's "Guide" is a thoroughly good, and we believe trustworthy, one; and while it deserves the title "practical," and will be of the greatest use to the visitor, the general reader might read it through with interest and profit.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

A Science Museum

THE fact that the Science and Art Department have had before them for at least ten years the proposal to establish a science museum, is shown conclusively enough in NATURE for last week. May I be allowed to draw attention to a still earlier suggestion of the same character? As far back as 1859, two years after the establishment of the Patent Office Museum, the Commissioners of Patents laid a Report before Parliament, in which the following passage occurs:—

"It is intended to make the Patent Office Museum an historical and educational institution for the benefit and instruction of the skilled workmen employed in the various factories of the kingdom, a class which largely contributes to the surplus fund of the Patent Office in fees paid upon patents granted for their valuable inventions. Exact models of machinery in subjects and series of subjects, showing the progressive steps of improvement in the machines for each branch of manufacture, are to be exhibited; for example, it is intended to show in series of exact models each important invention and improvement in steam propellers [steamboat propulsion] from the first engine that drove a boat of two tons burden to the gigantic machinery of the present day, propelling the first-rate ship of war or of commerce. The original small experimental engine that drove the boat of two tons burden, above referred to, is now in the museum, and is numbered one in the series of models of propellers."

Unhappily this brilliant project rested unfulfilled. "No. 1" of the series of models of steamboat propellers had but few followers, while other branches of mechanical science did not get so far as to have even a "No. 1." The conception was excellent, the execution lamentably deficient. Thus the collection which was to have expanded into a museum of mechanical and industrial science degenerated into an old lumber-room, and, instead of expanding over the ground originally allotted to it, contracted into its present dimensions.

Into the causes of this failure there is no need to enter. The thing has failed, and there is an end of it. Luckily there is a chance of something better now, and it is to be hoped that we shall soon have the collection belonging to the Patent Office divided into two parts—one part to be sent to the Science Museum, and the other to the nearest dust heap. So long as it belongs to the Patent Office, the aggregation of rubbish will be sure to continue. The Commissioners have never exercised a power of selection, and any foolish invention, so that it is only the subject of a patent, has the right of *entrée*. Naturally it is not the important inventions which make their appearance at South Kensington. As part of a Patent Office, a museum is practically worthless. It is hardly possible to imagine an invention which—at least to an expert—cannot be as clearly explained by descriptions and drawings as by a model. For purposes of experiment and instruction models are obviously invaluable. By no other means, for instance, can *motion* be rendered intelligible to a class of students or a popular audience. When the object, however, is simply to define what an inventor has discovered or constructed, so that it can be understood by an expert, a drawing and a description are nearly always much better—always as good—as any model. The only reason why the Patent Office should have charge of such a museum is that the officials of the office are in constant communication with the particular class likely to contribute to the museum. Patent cases are fruitful in models, constructed, not for the engineers, but to enable the engineers to explain to those who have no special mechanical knowledge the action of the different apparatus before them. Many such models are of no public interest, but many are well worth preservation, and it was thought that from these and like sources the Patent Office Museum would soon grow rich. The event has hardly justified the hope, but that is no reason why, under better management, the promises held out fifteen years ago should not now be realised. With all its deficiencies, the Patent Office Museum has done one good service. It has preserved some quite invaluable examples of early mechanical science which would otherwise have been scattered to the four winds—most of them to the west wind and the States. These are ready to form the best possible foundation for the mechanical section of the Science Museum, a section

which, in a great manufacturing country like this, ought certainly not to be the least important of all. H. T. Wood.

Society of Arts, Aug. 22

The Diurnal Inequalities of the Barometer

Like the author of the interesting paper on the daily inequalities of the barometer in Nature, vol. xiv. p. 314, I am one of those who are waiting for the appearance of the second part of Mr. Buchan's essay on this subject. Perhaps the coming meeting of the British Association at Glasgow may elicit from Mr. Buchan the result of his laborious investigations. I own that I am not only anxious to ascertain if his views coincide with my own,[1] but desire very much to have at my command the thorough discussion of the data for the eighty-six stations which Mr. Buchan has collected.

So far as a correct explanation of the inequalities is concerned, I believe it must be one that can dispense with the lateral movements of the air proposed by Mr. Blanford, and be applicable alike during the calm days of the "doldrums," and during periods of great wind disturbance. It must explain, too, seasonal differences in their amount, and we may infer that what will explain a seasonal difference will probably explain also a geographical difference of the same kind.

In the barometric co-efficients for Calcutta, supplied by Mr. Blanford, the semicircular one U'' is nearly twice as great in April as it is in July, and the quadrantal co-efficient U''' is one third greater in March than it is in June. The hour angle u' does not vary so much as it does in this country, and the angle u'' shows its usual very remarkable constancy. In England the co-efficient U''' seems to have a greater proportionate range than at Calcutta. This will be seen by the following monthly means obtained from Mr. Main's discussion of the observations made at the Radcliffe Observatory, Oxford.

Mean Daily Quadrantal Oscillation of the Barometer for each month at Oxford for the sixteen years, 1858-1873 inclusive. In units of ·0001 of an inch :—

March	120	September .	120
April .. .	118	October	109
May ...	101	November	90
June	98	December .	92
July ..	94	January .. .	74
August	108	February	111

The epochs of maximum effect seem here to correspond with the greatest thermometric range rather than with epochs of greatest heat. I think it will also be found in this country that this inequality is as large, if not larger, during continuous strong westerly winds as during quiet anticyclonic periods.

Like Mr. Blanford I was led to this subject by a study of the daily inequalities of the wind. My having arrived at a very different result must be my excuse for pointing out what seem to me to be points of difference between the conditions which he theoretically investigates and those which exist in nature. Mr. Blanford shows that "when a given quantity of heat is employed in heating dry air at the temperature of 80°, it raises its pressure more than seven times as much as when it simply charges it with vapour without altering the temperature." Mr. Blanford very properly premises that this occurs "while the volume remains constant." It is also implied that the volumes of air are of equal tension throughout. But where do these conditions obtain in volumes of the atmosphere? Such a volume, for example, as rests on a square yard, a square mile, or a hundred square miles of the earth's surface. This volume may easily be supposed to remain perfectly constant, while the tension of its parts may vary enormously. No ordinary addition of heat to the base of this volume will increase its total weight or sensibly add to the tension of the air at the surface of the earth. The added heat will alter the relative tension of portions of the lower third or half of the volume, and will be expended in raising to a small extent the centre of gravity of the whole. When this is done, that is, when the dynamical effect of the added heat is completed, the barometer at the base of the volume of the atmosphere will in reality read a little lower, instead of showing the greater tension required by Mr. Blanford's investigation. And this will be the case whether the added heat has expanded dry air only, or has evaporated particles of water already in the atmosphere. In either case I apprehend that during the upward movement of the warm air or of the *lighter* vapour the barometer would read lower than at the moment when the movement was completed.

An elevation of the centre of gravity of the atmosphere equal to two-thirds of a mile, barometer at 30 inches, would reduce the weight of the atmosphere by about the one-hundredth of an inch. The centre of gravity of the air over an elevated station like Leh in Ladakh would have to be raised several miles to produce so large a change of pressure as ·1034 of an inch, the difference between the maximum night and day value of co-efficient U' as given by Mr. Blanford—so many miles as, in my opinion, to compel one to look for some other cause for the production of part of the observed effect, and that cause, I believe, will be found in the dynamical one already indicated.

W. W. Rundell

[1] On the Diurnal Inequalities of the Barometer and Thermometer. *Quarterly Journal of the Meteorological Society*, Oct., 1874

Visual Phenomena

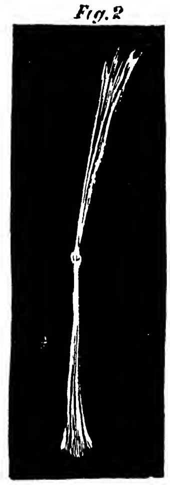
Although most people are familiar with the appearances which surround, or perhaps I should say form, the image on the retina of a luminous point, their origin, I believe, is not so generally known, and it is not uncommon to hear them ascribed to reflection from the eyelids and eyelashes, which in reality plays no part in their production. There are three distinct phenomena which go to make up the appearance of a luminous point, but they are not generally all visible at once. I will describe them for convenience of reference as phenomena A, B, and C.

(A). The luminous point appears to be surrounded by short rays, seldom more than a degree in length, generally much less, the length depending on the brightness of the point and the size of the pupil at the time.

These rays are what make a bright point look star-shaped (Fig. 1)

(B). Upwards and downwards from the point proceed two bundles of rays, each often 20° or more in length, and inclined to one another at an obtuse angle (Fig. 2).

Fig. 2



(C). Coloured rays such as are shown in Fig. 3, which are only seen when the eyelids are nearly closed.

These perhaps it is hardly necessary to say are produced by diffraction through the eyelashes.

(B) is due to refraction through the small band of tears, which is retained by capillarity in the angle between the inner edge of the eyelid and the eye (shown at t and t', Fig. 4), and which acts as a curved prism, although its effect is only visible when the lids are advanced far enough over the cornea to allow light which passes close to them to enter the pupil.

The following simple experiments show that this explanation is the right one.

1. While looking at a bright point so as to see (B), draw down the lower eyelid, the upper bundle of rays will then disappear. This shows that the upper rays are caused by the lower eyelid, and also that as the image on the retina is inverted, the light must take some such course as shown by the dotted lines in Fig. 5. Now in no conceivable way could reflection from the

lower eyelid produce this effect, whilst it is evident that a prism of the shape taken by the liquid in the angle must produce it.

2. If the bright point be examined in front of a looking-glass, so that the eye, its reflection, and the point are in a straight line, it will be found that (B) does not begin to be visible till the eye-lid is just beginning to eclipse the pupil, showing that it is the light which grazes the lid that produces the effect. I have accurately reproduced the phenomenon by fitting a lens of short focus

Fig. 3

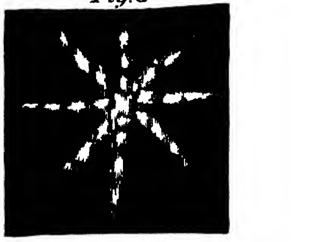
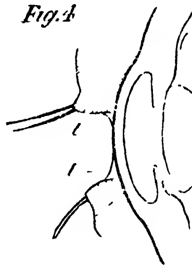


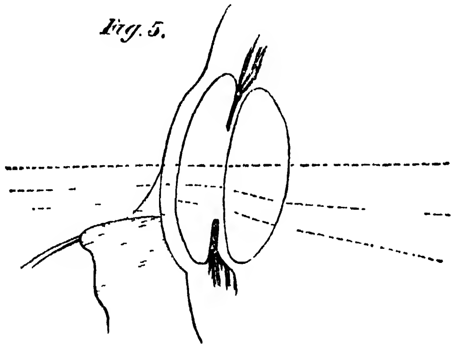
Fig. 4



into a pair of artificial eyelids, moistening the angle between the lens and lid, and photographing a bright point with the combination thus made. The diffraction effect (C) was also reproduced in this manner when the lids were brought close together.

The phenomenon (A) may be studied in the following manner:—Throw into the eye, by means of a lens or mirror, a pencil of light so widely divergent as to form a luminous patch on the retina, whose border is the shadow of the iris. If the pencil

Fig. 5.



proceed from a point, this border is well defined and dust on the cornea and any small irregularities in the distribution of moisture on its surface are rendered clearly visible by the diffraction rings and bands which surround their shadows. But what is most striking is the star-shaped figure (Fig. 6) which occupies the whole lighted area.

Fig. 6

If now the divergence of the pencil be gradually diminished, which it may be by withdrawing the eye further from the focus of the lens, this area diminishes in size and increases in brightness towards the centre, leaving, however, the rays of the star still bright, and protruding into the region which has now become unilluminated; and when the luminous point is far enough off to enable the eye to focus rays proceeding from it, the phenomenon (A) is seen to be the limiting form of this star-shaped figure. The rays in the figure correspond with the stellate structure of the crystalline lens, to which, therefore, I conclude that (A) is due.

ARNULPH MALLOCK

Antedated Books

As Editor of the Zoological Society's *Transactions*, I must maintain, in direct opposition to "Another F.Z.S.," that we set a *good*, and not a *bad*, example in dating our books. The parts of the *Transactions* not being issued at regular dates, I have adopted the plan of placing the date at which the paper is going finally through the press at the foot of each sheet, for the very purpose of giving its correct date as nearly as possible. The part is always on sale within a month at least, I think I may say, after this date; so that this date and that of publication are to all practical purposes identical.

P. L. SCLATER,
Secretary to the Zoological Society of London

Aug. 22

MR. R. BOWDLER SHARPE makes a singular defence to my comments on his "evil practice" of issuing, in August, 1876, a work dated on the cover May, 1875. He says that if I had looked into the interior I should have found "abundant evidence" to convince me that the date on the cover was a false one. Seeing that when I wrote my former letter I had only just received the number from the publishers, I had no need to search for further evidence of such being the fact. Mr. Sharpe must be aware that the covers of works issued in parts are often bound up for the express purpose of preserving a record of the date of issue. How will this plan operate in the case of the second edition of the "Birds of Africa?"

"Another F.Z.S." states that in his copy the date "May, 1875" has a line drawn through it. This is not the case with my copy, nor is it so in others which I have examined.

F.Z.S.

Kerguelen's Land

IF Mr. R. Bowdler Sharpe considers that, having published a description of the new Teal from Kerguelen's Land, he has done all that is necessary in relation to the collection of birds made by Mr. Eaton in that distant island, he will, I fear, find but few persons to agree with him. Most of his brother naturalists will side with me that our American friends have shown much greater energy in getting out a complete account of the ornithology of this interesting island at an early date than Mr. Sharpe in issuing a short notice of the single undescribed species.

THE REVIEWER OF "THE BIRDS OF KERGUELEN'S LAND"

A Large Meteor

I HAVE just seen a large meteor. It fell vertically in a line passing half-way between the pole-star and the nearer pointer, disappearing about 15° above the horizon. Where it came from I did not see. At disappearance it seemed a very elongated pear-shape, and changed colour from red to violet (commencing at the edges). Its horizontal diameter was about 20′. Time 8.10 P.M. about; my point of view, 4 miles due south of the dome of St. Paul's.

I may add, that on the night of Thursday, 10th, between half-past 11 and 1, while on a long drive in the neighbourhood of York, and looking up at the clear sky only as circumstances permitted, I counted twenty, and saw more, the moon shining brightly at the time.

RICHARD VERDON

London, Aug. 21

[Mr. Paul Robin, writing from Sheerness, states that on Monday evening, at 8.10 P.M., he saw a meteor brighter than Jupiter, with a white luminous train of about 5 deg. Its course crossed a line from the pole-star, joining the pointers.]

THE "CHALLENGER" EXPEDITION

WE have already published (vol. xiv. p. 197) the weighty testimony borne to the value of the *Challenger* Expedition by the leaders of science in Vienna. The following no less valuable address to Sir C. Wyville Thomson has been sent us for publication:—

To Prof. Sir C. Wyville Thomson, F.R.S., Director of the Civilian Staff of the "Challenger" Expedition, Edinburgh.

R. Museo di Fisica e Storia Naturale di Firenze, Florence, July 7, 1876

SIR,—The professors of the Natural Science Section of the Royal Institute of Florence have followed with the most intense interest the researches on the deep-sea fauna initiated by you during the *Lightning* and *Porcupine* expeditions, and so splendidly followed up during the voyage round the world of the *Challenger*. With anxious expectation we have followed the

results of your dredgings across the great ocean-basins of both hemispheres, and now that you and your able assistants have completed your great task so satisfactorily and are safely returned, we beg you to accept our most hearty congratulations and the expression of our united sentiments of admiration; for you have, indeed, revealed a New World to Biological Science and opened a new and most important field for physical research.

PH. PARLATORE,
AD. TARGIONI-TOZZETTI, Prof. of Zool. and Comp. Anat.,
A. GLEGNI,
ENRICO HILLYER GIGLIOLI, Prof. of Zool. and Comp. Anat. Vertebrates,
DR. GUELFO CAVANNA,
MGR. GUISEPPE GRATTAROLA (Mineralogy),
PROF. PIETRO MARCHI,
GIOVANNI ARCANGELI (Cryptogamic Botany).

The following is Sir C. Wyville Thomson's reply to the above:—

To the Professors of the Natural Science Section of the Royal Institute of Florence.

20, Palmerston Place, Edinburgh, Aug. 12, 1876

GENTLEMEN,—Allow me in my own name and in that of my colleagues on the Civilian Scientific Staff on board the *Challenger* to thank you most cordially for your kind letter of congratulation on our return to England, and on the success of our labours.

Owing chiefly to the manner in which throughout the whole of this undertaking the Admiralty have uniformly accorded the first place to the purely scientific work, and to the heartiness with which the objects of the scientific specialists have been seconded by the naval officers on board, we have certainly been enabled to carry out our investigations almost more fully and completely than we had a right to hope. We are well aware, however, that we have only now entered upon the most difficult if not the most important part of our task, and I can only say that we will do all in our power to justify the liberal encouragement which we have received from Government by working out fully the mass of data and materials which we have accumulated, and publishing our results as soon as possible in an appropriate form.

I need scarcely add how great a gratification it has been to us to receive assurances of sympathy and approval from so many of our most distinguished fellow-workers, but it seems to me that such assurances are more specially welcome from Italy, the wonderful country whose language and modes of thought have been before us as a model from our childhood, and which perhaps above all others commands our interest and regard.

I have the honour to be, Gentlemen,
Yours gratefully and respectfully,
C. WYVILLE THOMSON

A CONTRIBUTION TO THE NATURAL HISTORY OF THE HERRING

THE Meteorological Society of Scotland has made an important contribution to the natural history of the herring (*Clupea harengus*), the capricious movements of which have recently attracted attention and been discussed in the columns of NATURE. It is often asserted by the more observant persons who assist in the capture of the herring, that the *Clupea* family are lovers of very cold water, and it is, doubtless, from a knowledge of this fact, that the story of the herring being a native of the Arctic regions took its rise. Pennant's tale of these fish coming annually in a vast *heer* from the high latitude of the northern seas has been discussed and settled again and again. There need now be no hesitation in saying that Pennant erred; indeed, he only gave literary life to the fables of the fishermen, and, so far as we know, he made no personal effort to determine whether or not the herring was a migratory fish. It has been ascertained beyond doubt that the herring is a local animal, the different varieties of which can readily be identified. Dealers or fishermen are able to distinguish between a Loch Fyne herring and one captured in the Frith of Forth or in the Bay of Wick, or any other sea or frith. As a matter of fact, the herring is found on British shores all the year round, and there is no authority for supposing that the varieties taken in different localities are members of any great general body of these fish, or that there is one great shoal in existence every year, which, at a certain season divides and then subdivides itself, *à la* Pennant.

To come back, however, to the new discovery. We are indebted to the Meteorological Society of Scotland for some interesting experiments which have been made as to the temperature of the waters in which the herring can live with the greatest amount of comfort to itself, and, when known, with the greatest benefit to its captors. It has been determined by the experiments of the Society that the take of herrings is most abundant where the temperature of the sea is lowest. It was found in 1874 and 1875 that "the temperature of the sea, off the east coast of Scotland, from the middle of August to the close of the fishing season, was continuously and considerably higher in 1875 than in 1874, and that the catch of herrings was continuously and considerably lower during 1875 than during the same period of 1874." As regards the difference between surface and bottom temperature and their relation to the fishery, it has been noted that when the temperature of the surface of the sea is high, the fish are found in the deeper parts of the water. "The fish prefer, apparently, so far as the inquiry has gone, the lower to the higher temperature." When a thunder-storm has prevailed on any of the days devoted to the fishing a good take of herrings may be expected by the fishermen, "but, on the following day, few, if any fish are caught over that part of the coast, *unless at the extreme verge of a deep part of the sea* as if the fish were retreating thither." The Meteorological Society of Scotland are desirous of extending their inquiries and observations, and they wish the fishermen to aid the inquiry by taking the trouble of "observing the temperature of the sea at the surface and also at the depth at which the fish strike the nets." In other countries than ours observations of a relative kind to those prosecuted by the Scottish Meteorological Society of Scotland have been successfully accomplished. The Dutch have ascertained many interesting facts regarding the effects of temperature on fisheries. The Norwegians have also been prosecuting similar inquiries. Herr von Freeden, of Hamburg, Director of the German Seewarte, has also made observations, both as regards temperature and direction of wind. As regards the latter, he has come to the conclusion that north-west winds are the best for large catches, and northerly winds better than southerly, westerly better than easterly; also, that moderately strong winds, sufficient to ruffle the surface of the sea, are better than calm weather, and light winds almost as unfavourable as still breezes; a ruffling of the sea being in his opinion of considerable importance to success of fishing.

These are important discoveries, so far as they go, and must ultimately exercise considerable influence on the practice and results of the herring fishery. Hitherto the men have fished as in the dark, so far as regards the kind of knowledge which has just been found for them. That the month of August is a good time to seek the herring is about all that fishermen do know; the most likely part of the water in which to find them, or the depth at which they may be lying, they cannot tell. When the fishermen *shoot* their nets they may not fall in the path of the fish; the herrings they seek may be either above or below the snare which the men have let into the water for their destruction. By a fruitful continuance of the observations we have referred to, we shall be able to conduct the herring fishery with greater exactitude and likewise with more economy of time.

TELEPHONES AND OTHER APPLICATIONS OF ELECTRICITY

IN a recent number we gave some account of the telephone of Mr. Elisha Gray; in the present article we propose to refer to another form of this instrument, as also to the so-called electric telegraph without conductors, and its relation to electric tuning-forks. For our information, as well as for the illustrations, we are indebted to papers by M. Ch. Bontemps, in our French contemporary, *La Nature*. To begin with the last-mentioned application of electricity.

For this new process of telegraphy it is claimed that we may communicate with any person at any distance without having taken the precaution of previously establishing a continuous wire between the two stations.

M. Bourbouze, in 1870, in continuation of previous experiments, attempted at Paris to utilise the Seine as a conductor between two stations, the Jena and Austerlitz bridges. This attempt, if successful, would then have been of great practical value, as it would have enabled besieged Paris to communicate with the outside world. An electric pile placed on the Jena bridge sent alternative currents to Austerlitz bridge. These currents were received in a galvanometer invented by M. Bourbouze, and read by the oscillation of the needle to right or left. The experiment appeared successful; the elements of a language were proved in this attempt. There was no opportunity, however, of further testing its utility; a mission was organised for the purpose of establishing a station beyond the lines, but ere it could be carried out the armistice rendered further experiment unnecessary. M. Bourbouze has, however, again taken the matter up; but it is necessary to be on our guard against cherishing hopes which seem premature.

M. de Parville points out very well the objection which common sense suggests. "Suppose," he says, "that we should all wish to speak by this means from one end of a city to the other. Each possesses his talking-needle and his pile. Each needle goes marching ceaselessly to right, to left, obeying everybody at once. It will speak for all correspondents at the same time. Messages will get entangled and completely mixed up. Here is a new Tower of Babel. We won't be able any longer to understand each other. The electric wire of the ordinary telegraph, on the contrary, serves as a track of union, and shuts the door to indiscretions. Thus, *yes*, we may communicate to a distance without a wire; *no*, we should not be able to supply by this new system, since we should find ourselves in the condition of a crowd speaking at once miscellaneously, without being able to make itself understood. For the new system to become applicable, it would be necessary to find the means of giving to each current an individuality which would enable a correspondent to recognise it among the thousands of currents which may circulate at one time. We have no right to doubt the future, and we may hope that some day such a means will be discovered."

In this connection let us explain the remarkable work of a Danish engineer, M. Paul Lacour. How can we give to each current an individuality which will enable us to recognise it?

When we consider the most common acoustical phenomena, for example, the transmission of an air played by an orchestra, which is perceived by all the audience at considerable distances from the executants, we have some difficulty in analysing this effect. Physics tells us that the sounds produced by each instrument have their proper tone and their distinct measure; in other words, the notes which come from a violin, a flute, a trombone, correspond to different vibrations transmitted by the atmosphere and characteristic of each note. Besides, the rhythm in the succession of the notes, which makes the measure in music, produces the cadence, constituting with the tonality and the timbre of the instruments the general effect of the air which impresses itself upon us. The transmission is so precise that an ear detects in this assembly of performers a mistimed note, anything out of tune in the midst of the harmony of the air. In our exposition it is the mistimed note which will serve us as a landmark.

Suppose a series of three tuning-forks vibrating continuously and producing—the first, 100 vibrations per second; the second, 300; and the third, 500. It is easy to conceive that each of these tuning-forks may interrupt and establish an electric current with intermissions regulated by the number of its vibrations. If we have three tuning-forks identical with the three former, we can conceive each group to be placed at the extremity of an electric line serving as a medium of connection. We shall see reproduced the phenomenon of the musical air transmitted to a distance: the three transmitting tuning-forks act respectively on the three receiving forks by means of the medium which connects them.

Let us admit, meantime, that by an effort of the will we may either set a-going or stop any one of these tuning-forks in accordance with a cadence that will not necessarily coincide with its regular action, we shall find at the other extremity in the symmetry of the perturbed instrument, the same discordant manifestations. The mistimed note will be as faithfully transmitted as the harmonic vibrations. The bearing of a practical realisation of this conception will be easily understood; it opens the way to the indefinite multiplication of diverse transmission by the same conductor; it is also the germ of a solution of transmission by multiple conductors, with the power of individualising each current.

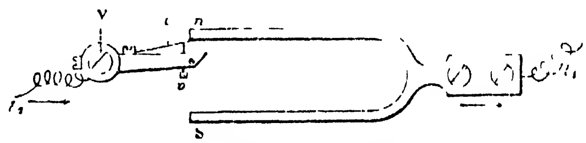


FIG. 1.—Transmitting tuning-fork.

What is necessary to the fulfilment of this condition? 1. It is necessary to construct tuning-forks whose movement is maintained by an electric current; this problem has been solved. 2. It is necessary that these forks emit currents whose phases correspond exactly with their movement, a problem which has also been solved. 3. Finally, we must be able, in a very small interval of time, say one second, to arrest and put in action a great number of times (100 at least) each of these forks. This last point is the only one which presents any difficulty. We see that this difficulty is only a problem of construction; it is necessary to operate with very small masses in order easily to overcome inertia. The success of M. Marcel Deprez authorises us in thinking that the third condition may be realised.

We shall conclude this part of the subject by a reference to figures. We shall show how a diapason vibrating continuously can send currents of the same intermittence along an electric line. Fig. 1 represents the necessary apparatus. The arm n of the tuning-fork encounters alternately the platinum of the tongue c, whose opening is regulated by the screw v. A current entering by l_2 is closed every time that the extremity n touches the slip c, and is opened when the vibration of the tuning-fork is away from the extremity n; there is only required for this that by the wire l_1 issuing by the exterior conductor, the line, there be propagated a series of electric undulations reproduced exactly in the material vibrations of the arm of the tuning-fork.

We have, however, to show how we can determine and mark the character of an intermittent current arriving by the telegraphic wire. Fig. 2 represents the arrangement

of the intermediate station traversed by the line L L; A, B, C are three tuning-forks similar to those of the transmitting station. The fork B, for example, which is in unison with the current, will enter into vibration while the others remain mute. This fork B will then touch the platinum tongue (shown in Fig. 3), and there will be established in the circuit $b\,b'$ a local current of the pile U whose poles are applied respectively to a, b, c, and to a', b', c'. This local current will be intermittent in pro-

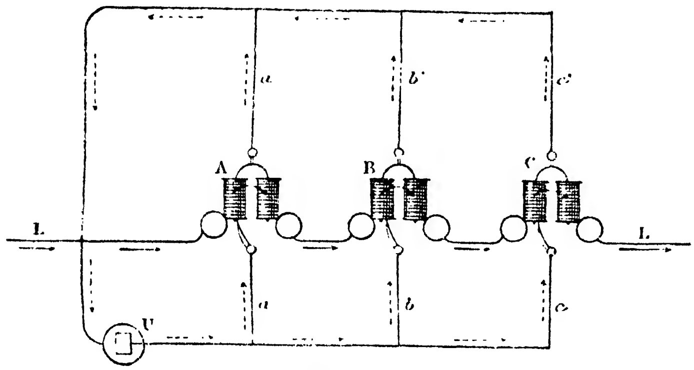


Fig. 2.—Intermediate station.

portion to the time of the tuning-fork, but on account of the rapidity of the pulsations it will show itself in many cases as a constant current either by effecting chemical decomposition, by causing the deviation of an electric needle, or by energising an electro-magnet.

Fig. 3 shows the arrangement which has been established to produce interruptions for correspondence by means of the regulated vibrations of the tuning-fork. The

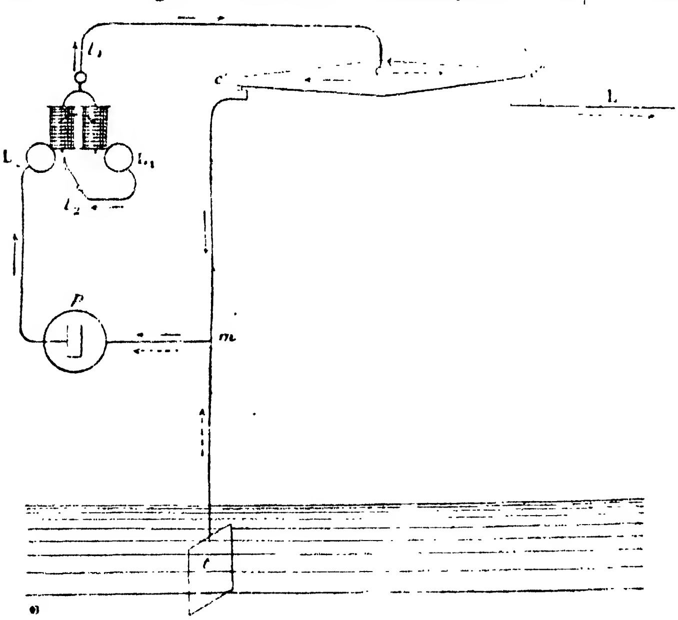


Fig. 3.—Manipulator.

manipulator C, which can oscillate around a central axis, rests sometimes on c' sometimes on c''. Acording as the lever C is supported on c' or c'', it closes the circuit of the intermittent current emitted by the tuning-fork, either by the earth of the transmitting station or by the earth of the receiving station, after traversing the guiding wire.

It would seem, then, that the only objection to the practical realisation of the system of multiplying correspondence in one or more directions, lies in the greater or less facility with which a tuning-fork can be stopped and put in action; it is a question of mass, and cunning fingers will certainly some day devise for us apparatus sufficiently small to realise this desideratum.

With regard to the telephone, an instrument allied in some respects to the apparatus above referred to, we shall specially refer here to that which bears the name of M. Reuss. For an account of Mr. Gray's instrument, see vol. xiv., p. 30. The arrangement adopted by M. Reuss will be seen in Figs. 4 and 5—the former representing the transmitting apparatus, and the latter the receiving apparatus.

At the station at which the musical air is played (Fig. 4) a wide tube T issuing from a box K receives the vibrations of air produced by the instrument. The purpose of the box is to collect and strengthen the sound. On the upper part is stretched a membrane *m*, which vibrates in unison with the impulses it receives. To transform the movements of this membrane into the harmonious emissions and interruptions of an electric current, it is sufficient to establish a series of connections easy to conceive.

Suppose that a pile, one of whose poles is the earth, is attached by the other electrode to a handle marked 2 in Fig. 4; from this a metallic conductor formed by a thin plate of copper *i* and ending in a disc of platinum *o*, leads the current in front of a point borne by the lever *a b c*. Every time that the membrane *m* is raised, the point touching the disc, the current will be established; on the other hand it will be broken when the membrane returns to its normal state. The box K is represented cut away at the upper part in order to show the arrangement of the membrane and the electric communication which repeats the vibrations. In order to transmit to any distance 100, 200, 500 kilometres the electric current, it is necessary that a line should issue from the knob 1 (Fig. 1), and be attached to knob 3 (Fig. 2, which represents the receiving apparatus). The latter is formed by an iron rod *d d*, around which is rolled insulated copper wire, one extremity of which ends at the knob 3, and the other in the earth by the screw 4, for the purpose of completing the circuit of the pile of the issuing station. The rod, *d d*, is of the size of a knitting-needle; the coil, *g*, formed by the combined wire and rod, is supported on a box, B, having very thin sides; above is the lid, D. The object of the whole arrangement is to strengthen the vibrations which are produced by the successive interruptions of the current across the rod, *d d*.

What is noteworthy in this system is that the vibrations of the rod, *d d*, are exactly synchronous with those of the membrane, *m*, and consequently with those of the instrument, the air from which has been played in the tub, T. Not only is the measure indicated, but the tonality as well, the two elements which make up the melody, height of sound, and interval of notes, all is reproduced automatically without possibility of error.

To complete the description, we must add that there is on Fig. 1, a lever, *ts*, and an electro-magnet, E E, the ordinary appendages of a Morse telegraph. Also on Fig. 2 is seen the manipulatory lever; there is also a receiver, not represented in the figure.

In order to appreciate the full value of the telephone, it is necessary to examine the form given to the box, K; the best arrangement hitherto discovered consists in bending the sides so as to amplify the effect on the mem-

brane by successive reflections. The power of the receiver is also increased by the introduction into the coil of several rods of iron; the sound originally somewhat snuffling, thus acquires a more agreeable tone.

M. Reuss calls the attention of physicists to the experiment; we think, with him, that there is here the germ of notable improvements to be made on the electric telegraph.

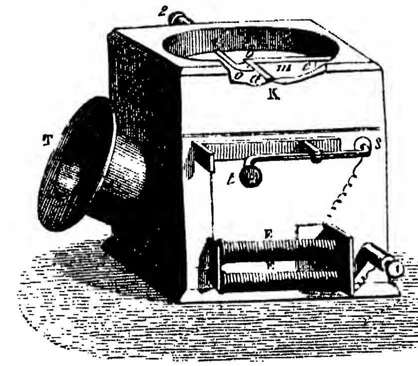


FIG. 4.—Sending apparatus.—K, box to collect the vibrations; *m*, caoutchouc membrane closing the box; *e*, platinum disc fixed to the membrane; *a b c*, movable lever, supported by the point on the membrane; *t s*, manipulating keys for correspondence; K K, receiving electro-magnet for correspondence; 2-1, screws to attach the communicating wires to the pile and with the line.

We do not, however, believe that in its present state, the invention is so complete that we can, at a distance, repeat on one or more pianos the air played by a similar instrument at the point of departure. There is a possibility here, we must admit, of a curious use of electricity. When we are going to have a dancing-party, there will

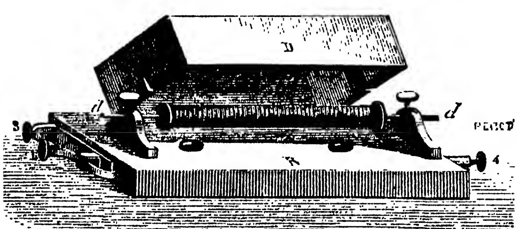


FIG. 5.—Receiving apparatus.—B, box to strengthen the vibrations; D, lid of this box; *d d*, iron wire vibrating by the passage of the current; *g*, coil through which the current passes; *t' s'*, manipulating key for correspondence; 1, 2, 3, screws to attach the communicating wires to the pile and to the line.

be no need to provide a musician. By paying a subscription to some enterprising individual, who will, no doubt, come forward to work this vein, we can have from him, a waltz, a quadrille, or a galop, just as we may desire. Simply turn a bell-handle, as we do the cock of a water or gas-pipe, and we shall be supplied with what we want. Perhaps our children may find the thing simple enough.

INTERNATIONAL CONGRESS OF AMERICANISTS.

July there met in the city of Nancy a congress of a somewhat novel kind (NATURE, vol. xii. ...), which, at the time, did not attract very much attention, but which, during its four days' sitting, did a considerable amount of work of varied value. This was the International Congress of Americanists, organised by a society recently formed in France under the designation "La Société Americaine de France." The society itself appears to be French, though the congresses are intended to be international in their character, and among those who were members of the last congress (though not necessarily present) were many eminent men belonging to all parts of the world. Among English names we notice those of Dr. Birch, Mr. Charles Darwin, Mr. Franks, Sir John Lubbock, Mr. R. H. Major, Prof. Max Müller, Sir Henry Rawlinson, Sir Charles Trevelyan, Mr. Trübner, and others. Delegates from various countries were present at the congress, and although most of the papers were by Frenchmen, still a fair proportion were by foreigners, chiefly Americans and Scandinavians. Two thick octavo volumes[1] contain the proceedings of the congress.

The object of this French society in holding these congresses is to contribute to the progress of ethnographical, linguistic, and historical studies relative to the two Americas, especially for the times anterior to Christopher Columbus, and to bring into connection with each other persons who are interested in these studies. The subscription is only twelve francs, and the council is composed of a certain proportion of French and of foreign members. The president of the Nancy congress was the Baron de Dumast, but at each of the four *séances* for the reading of papers he very gracefully called to the chair a distinguished foreign member to preside over the day's proceedings. During the congress an interesting exhibition of objects relating to American ethnography and antiquities was held.

The subjects with which the congress dealt were divided into three sections—History, Ethnography, and Linguistics and Palæography, though, as might be surmised, many of the papers bore on all these subjects. Though the subjects were thus divided, the congress met as one body each day.

Such an international congress as this, it will be admitted, might do great service to science. The ethnography and prehistoric archæology of America are of the highest importance; they are a prime factor in the great problem of the world's ethnography. If, then, an international American congress were based on well-defined principles, and if its work were conducted in accordance with the universally recognised rules of scientific method, it might give a powerful impulse to the progress of American ethnology in particular, and to ethnography in general. We shall briefly endeavour to give the reader an idea of the value of the contents of the two volumes before us.

Among the first papers is one of considerable length, by M. E. Beauvois, the purpose of which is to prove that the "Irland it mikla," or "Hvitramannaland" of the early Icelandic chroniclers was a colony founded by Irish missionaries, apparently near the mouth of the St. Lawrence, long before even the Norseman knew anything of America. One cannot but admire the learning, ingenuity, and enthusiasm of M. Beauvois, but the verdict must be the Scotch one of "not proven," with a note that it was scarcely worth while calling together an international congress to listen to a paper of this kind.

This may be regarded as a type, and rather a favourable one, of a large number of the papers read at the Nancy congress, papers whose object was to show the intimate connection which in prehistoric times existed between the peoples of the Old World and those of the New. A paper by Prof. Paul Gaffarel of Dijon, for example, had for its object to show the great probability that the Phœnicians had found their way across the Atlantic to America, North and South, and that in various ways they left traces of their presence behind. This is a somewhat more sober paper than that of M. Beauvois, still the verdict must be essentially the same.

Of course the questions of Buddhists in America and of "Fu-Sang" got their share of attention, with the usual

[1] Congrès International des Américanistes. Compte-Rendu de la Première Session, Nancy, 1875. (Paris, Maisonneuve et Cie.)

unsatisfactory result. Fortunately there were some solid men at the congress who were able to perceive the utter futility of discussions of this kind. M. de Rosny, for example, had frequent occasion to recall the attention of the congress to its main purpose, and to remind the members that while we knew comparatively so little of the American aborigines and of their remains, it was a waste of time and energy to discuss the civilisation of any other country. "Our duty," he said, "is to establish formally, against all the crotchets which have hitherto infested the domain of Americanism, a method. Every hypothesis which is not based on certain proofs is of no scientific value;" and Dr. Dally justly remarked that there is no special "Americanist method," but that there is a scientific method, whose rules are quite sufficient for this new department of science. "No documents," Dr. Dally continued, "are adduced in support of these connections between the Old and the New Worlds; we must, therefore, provisionally consider them as non-existent. All the alleged analogies are only vain appearances. The presumptions are, on the contrary, against the hypotheses of an analogy or a filiation between the religions of Mexico or of Peru and those of Eastern Asia. The solution of the question is that the Americans are neither Indians, Phœnicians, Chinese, nor Europeans; they are Americans." "All these hypotheses," M. de Rosny remarked again, "of Asiatic influences in America are very piquant: it is the proof which is always wanting." What a pity a few men like M. de Rosny and Dr. Dally were not appointed beforehand to decide on what papers were deserving of the serious attention of the congress! However, wisdom comes by experience. The fairly moderate paper on Fu-Sang, by M. Lucien Adam, might have been admitted, as might also that of M. Gravier on the Deighton Rock inscription, but we are sure that all the papers thus admitted could have been published in one-third of the space of these two volumes.

M. Lévy-Bing brought much learning to bear on the Grave Creek inscription for the purpose of proving it to be Phœnician, with the usual unsatisfactory result, we are sure, on all unbiased listeners. Perhaps the most deliberate and cold-blooded attempt to prove an intimate connection between America and Old World civilisation was made by Prof. Campbell, of the Theological College, Montreal, in his paper, "The Traditions of the Ancient Races of Peru and Mexico identified with those of the Historical Peoples of the Old World." His object is to prove that the Peruvians and Mexicans had "their original home on the banks of the Nile, and that their traditions relate primarily to an early national existence either in Egypt or the neighbouring region of Palestine;" and besides various other conclusions, "that there is the strongest reason for finding the affinities of the civilised races of ancient America, not among the Turanian or Semitic, but among the Aryan or Indo-European families of the world." This is rushing to a conclusion with a vengeance, and some of the more sober members of the congress had good reason to animadvert on the "haste to conclude" manifested by many of the Americanists, and the want of patience to wait for more light. An idea of the value of the "facts" on which Prof. Campbell builds his sweeping conclusions may be gathered from the following extracts:—"Animal worship prevailed in Peru, and it is worthy of note that flies, called *cuspi* (a word of the same origin as the Semitic *zebub*, the Latin *vespa*, and the English *wasp*) were offered in sacrifice, thus recalling the *Baal-zebub* of the *Phili-sheth*." "In *Manco* I find the first monarch of universal history, the Egyptian *Menes*, the Indian *Menu*, the Greek *Minos*, the Phrygian *Manis*, the Lydian *Macon*, the German *Mannus*, the Welsh *Menev*, the Chinese *Ming-ti*, and the Algonquin *Manitou*"—and so on through endless ingenuities. Is not this comparative philology playing at "high jinks?" and is it not one more striking proof that to trust to language alone in questions of ethnography is to trust to a chain of sand?

While the Baron de Bretton's paper on the Origins of the Peoples of America contains some suggestions of value, it also, like the one just mentioned, is disfigured by many etymological fantasies. It is quite legitimate to try to show that America may have been in part peopled from Europe, but to base such a theory on arguments like the following makes one almost despair of the progress of scientific method:—"The first invaders from whom, according to the tradition of the Toltecs, that people were descended, were called *Tans*, *Dans* (Danes!). Their god, *Teoti*, strongly resembles linguistically the Greek *theos*, Latin *deus*," &c. The temples of this god were called *tescalli*, "a word which comes from Greek *theos* and Celtic *ca-cas*, house." A god, *Votan*, is probably *Wodin*, and *Thara*, *Thor-as Asa-thor*. *Azlan*, the supposed original home of the Aztecs, is, according to Baron de Bretton, evidently Scandinavian *Asaland*, country of the *Ases*, of the *Asiatics*, of the *Aztecs* themselves. What answer can be made to such etymological legerdemain?

The Abbé Petitot has been for many years a zealous missionary in the Athabasca-Mackenzie region of North America, and has made some valuable contributions to a knowledge of the geography of that region; not content with this, however, he is eager through the medium of language to prove the unity of origin of the human race. He argues that because certain North American Indian words have a more or less distant resemblance to Chinese, Malay, Tamul, Hebrew, Greek, Latin, Japanese, German, English, &c., therefore all these are descended from one common stock. We shall give only one specimen of the Abbé's easy-going comparisons: English *each*, he tells us, is the same word as Hebrew *isch*. He gives pages of this sort of thing. It is easily done; any ignoramus with the dictionary of a dozen different languages before him could do it. The "Tower of Babel" is the Abbé's starting-point in tracing the diversities of human speech.

It seems to us a pity that the reputation of an international congress that might do much good should be endangered by puerilities such as those we have referred to. We hope that in this their first meeting the froth has come to the surface, and that in future meetings means will be taken to prevent middle-age word-puzzles being foisted on the congress.

The two volumes, however, contain some papers of real value; these we have space only to name. Prof. Luciano Cordeiro's (of Coimbra) paper on the part taken by the Portuguese in the discovery of America is of considerable interest, and shows great research. A paper by M. Paul Broca on two series of crania from ancient Indian sepulchres in the neighbourhood of Bogota is a model of careful observation and reasoning. M. J. Ballet, of Guadaloupe, has a long memoir on the Caribs, full of information. A paper by M. Julien Vinson on the Basque language and the American languages is able and scholarly and cautious. He shows that in structure and grammar they have many points of resemblance, but that on this ground there is no reason whatever for concluding that they or their speakers have a common origin. Other papers of value are Dr. Cornilliac's on the Anthropology of the Antilles, Mr. Francis A. Allen's on the Origin of the Primitive Civilisation of the New World, an elaborate paper, the result of great research, and M. Oscar Comettant's paper on music in America before the discovery of Columbus.

On the whole, we cannot think that these two volumes show that this International Congress of Americanists has done much in furtherance of the object for which it met, and we shall look with interest for the results of the second congress, which will meet at Luxembourg in September, 1877.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF 1882, May 17.—The following elements of this eclipse depend upon the lunar tables of Damoiseau and the solar tables of Carlini, and are therefore not intended to be used in a calculation of the precise circumstances for any place. They will, nevertheless, serve to afford a better idea of the character of the eclipse near the central track than can be obtained from Hallaschka's map in his *Elementa Eclipsium*, where by an error of calculation the eclipse is shown *broadly annular*.

Conjunction in R.A., 1882, May 16, at 19h. 42m. 25s. G.M.T.

	°	′	″	
R.A.	53	56	53·3	
Moon's hourly motion in R.A. ...		36	14·4	
Sun's " " "		2	28·6	
Moon's declination	19	38	41·9	N.
Sun's "	19	19	42·0	N.
Moon's hourly motion in decl. ...		36	14·4	N.
Sun's " " "		2	28·6	N.
Moon's horizontal parallax		58	15·1	
Sun's " "			8·8	
Moon's true semi-diameter		15	52·4	
Sun's " "		15	48·8	

The equation of time is 3m. 50s., subtractive from apparent, and the sidereal time at mean noon, May 17, 3h. 40m. 19·2s.

Instead, therefore, of being broadly annular, the eclipse will be narrowly total on the central belt.

	h. m		° ′		° ′
Central eclipse begins	17 55·0	in Long.	3 26 W.,	Lat.	10 32 N.
" " at	noon	"	63 27 E.,	"	38 27 N.
" " ends	21 20·8	"	138 29 E.,	"	25 17 N.

The eclipse is total in Upper Egypt and the Peninsula of Sinai, points on the central line being 32° 25′ E., 26° 57′ N., and 34° 23′ E., 27° 57′ N.

These elements also give totality for about twenty seconds at Shanghai: middle at 5h. 21·2m., local mean time, sun's altitude, 17°.

COMETS OF 1847.—In the last number of the *Astronomische Nachrichten*, Dr. Schur, of the Observatory at Strasburg, has given definitive parabolic elements for the comet discovered by Schweizer at Moscow, on Aug. 31, and last seen at Pulkowa on Nov. 28—an isolated observation. Elliptical elements had been assigned to this body, but the more complete computation by Dr. Schur shows that there is no sensible deviation from the parabola.

Greater interest attaches to another comet of the same year—that detected on July 20, by Brorsen at Altona, which was observed by Rumker till Sept. 12. The observations can hardly yet be considered as having been thoroughly discussed, though it may be presumed that D'Arrest used the last Hamburg observation in calculating his second ellipse (*Ast. Nach.*, No. 662), and Dr. Gould investigated elements with the whole, or nearly the whole, of the observations before him.

D'Arrest, by his second calculation, found the period seventy-five years; Dr. Gould gave eighty-one years; hence this comet has been considered to form one of the singular group which appear to revolve in something less than the period of Uranus; it must, however, at present be regarded as the least certain of the number, with respect to length of revolution. It presents a case where, as Dr. Gould remarks, very small changes in the fundamental places, even the slight change of the parallax due to more accurate determination of the comet's distance is "sufficient to change materially the form of the resultant orbit and the period deduced." His final elements exhibit a decided preponderance of sign in the errors when compared with the August observations, though he appears to have suspected the cause to have been mainly the difficulty attending exact computation from the elements in such a case. The observations will be found in a collective form in his paper concluded in vol. i., No. 19, of the *Astronomical Journal*—a periodical, by the way, of which it is difficult now to procure complete sets. The greater number are also found in *Astronomische Nachrichten*, vol. xxvi. D'Arrest furnishes no particulars of his second calculation, but gives the elements the preference over his first set, in which the period of revolution was considerably longer.

A further calculation may possibly lead to a more definitive value for the major axis; at present it appears that when the comet is re-discovered it is likely to be by accident rather than from any approximate knowledge of the epoch of ensuing perihelion passage and organised search.

A still more worthy matter of investigation, however, is the orbit of Olbers' Comet of 1815, due, according to Bessel, in less than eleven years. It is pretty certain that, with the introduction of improved solar tables and star-places for new reduction of such original observations as we possess, the fundamental positions might furnish a still more reliable orbit for 1815, while the re-calculation of the perturbations from more exact values of the masses than were at Bessel's command, may lead to a nearer determination of the time of next perihelion passage, which he has fixed to 1887, February 9.

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THIS year's Congress was opened at the Hôtel de Ville, Clermont, on Friday, August 18, under the presidency of Prof. Dumas, the well-known chemist and the perpetual secretary of the Academy of Sciences. M. Dumas praised in warm terms the spirit of individual initiative so largely developed in England, and he compared the British Association with her younger sister, the French Association. He spoke in high terms of English men of science, and referred to the Exhibition of 1851, and the important results which have followed it in the development of permanent scientific institutions in England. M. Dumas acknowledged the zeal of the French Government in helping science, and he showed that science must be promoted not only by benevolent and intelligent individuals, but also by the State. He, in eloquent terms, presented to the assembly the testimony of his long-continued labours extending over a period of more than sixty years, as a proof that science was conducive only to happiness. He advised men of science not to meddle either with theology or with philosophy, but to leave all questions in these regions in the hands of theologians and philosophers. The province open to science is large enough to give every satisfaction to the widest ambition.

The address was received with enthusiasm. The mayor of Clermont, M. Moinier, a barrister by profession, delivered a very sensible address, making allusion to the so-called "grands jours d'Auvergne," when many centuries ago legislators held their meetings in the very place where a parliament of science was then assembled. He said, moreover, that science, which was ignored in those days, was supposed now to have the duty of ruling the rulers of mankind.

M. Cornu then addressed the assembly on the present condition of the Association, which is eminently satisfactory. One of the most important announcements he had to make was that the Association, since its last meeting, has been recognised by Government as "of public utility," which is equivalent to the granting of a charter in England, and which will not only be of advantage to the Association, but, we believe, will enable the Association to be of greater benefit both to France and to science. To celebrate this episode in its history, M. d'Eichthal, to whose efforts it was largely owing that the privilege was

conferred, has presented the Association with a gift of 10,000 francs. The Association has been able to distribute assistance to those engaged in scientific research to the extent of 7,000 francs during the past year; of this sum 5,000 francs was accorded to Dr. Janssen as a contribution to the expenses of his recent voyages, and 2,000 francs to M. Chapelas-Coulvier-Gravier, to enable him to continue his researches on shooting stars. M. Cornu referred to the great importance of the Puy-de-Dôme Observatory, of which we have frequently spoken, and the formal opening of which had been deferred in anticipation of the present meeting. He concluded by eloquently urging the Association to continue to be animated by the spirit in which it was begun in the days of France's sore distress, to keep free from all party spirit, and to seek to be spoken of only and always as the friend of science and of the country.

The treasurer, M. Masson, gave an account of the state of the funds, which is very satisfactory. The Association is prosperous, numbering 2,200 members, including 200 ladies. The receipts for the Nantes meeting were greater by 400*l.* than the expenses. The funds of the Association amount this year to 7,000*l.*

In the evening a reception was held at the Hôtel de Ville by the mayor, which was perfectly successful.

On Saturday, at two o'clock, the several sections met to appoint their officers. Among the strangers present were Lord Houghton, Dr. Gladstone, the Rev. S. J. Perry, Mr. Eaton, Prof. Boyd Dawkins, and several other Englishmen.

M. de Mortillet, the sub-director of St. Germains Museum, has been nominated the president of the section of Anthropology. He delivered an address on the origin of superstitions. He showed that the present superstitions must be mostly connected with old Celtic populations.—M. Tchebycheff, the Russian geometer, has been appointed president of the Section of Mathematics. M. Tchebycheff exhibited a machine for performing addition and subtraction with extraordinary rapidity.—M. de Lucas presented the designs for the construction of a machine intended for the fabrication of prime numbers.

The places of interest in and around Clermont are open to the inspection of the members of the Congress, as is the case at meetings of the British Association, consequently the Sunday excursions have been numerous and highly attractive. The prehistoric archæologists visited the palæolithic habitations recently discovered at Issoire. A pleasure trip was made to Vichy, and a large number of members went to Thiers. The excursionists to Vichy were welcomed by the Mayor, Dr. Cornil. Among the toasts proposed was that of Lord Houghton, as a Vice-President of the British Association, who made a suitable reply.

In the city of Clermont are located the celebrated incrusting fountains, which convert into stone, wood and even animals. A rich collection of specimens has been opened for inspection, and will be visited officially by the Section of Geology this week.

An incident has occurred which created a little sensation. The members were assembled in a general meeting to hear a lecture on the mountains of Auvergne, when an intimation was received that the lecturer had been taken ill. M. Claude Bernard, the well-known physiologist who was present, was therefore invited to deliver an address. He lectured on the sensibility of plants, a subject which he has been investigating.

SCIENCE IN GERMANY

(From a German Correspondent)

M. W. SIEMENS has recently endeavoured to determine the velocity of propagation of electricity in suspended wires. His method of observation consists in the employment of two insulated Leyden jars (or two charge tables), the outer coats of which are metallically connected together. The inner coating of one jar is directly connected by a short wire with a metallic point; that of the other is also connected with this point, but by a long circuit line. Opposite the point stands a rotating metallic cylinder connected with earth. When the outer coats of the jars are connected with earth, the electricity of the inner coating of both jars at that moment becomes free, and is discharged through the point and the rotating cylinder to earth. If the rotation is sufficiently rapid, and the line long enough, there are produced on the smoked cylinder two marks with an interval between them, which is the measure of the time the electricity took to pass through the wire line from the jar to the point. This arrangement was also modified by placing two points, instead of one, opposite the metallic cylinder; the one being connected directly with one jar, the other by the line with the other jar. A discharge of the jars was first obtained while the cylinder was at rest, and then the discharge was made with the rotating cylinder.

M. Siemens thought at first that the velocity of propagation of electricity must be proportional to the specific conductivity of the material. In discharge of a jar through a caoutchouc tube filled with water, or through a wet thread, no time difference could be perceived between the mark of the direct discharge, and that of the first partial discharge through the liquid. It was the same with discharge of the jar through a strong caoutchouc tube, 100 feet long, and 20 mm. clear diameter, which was filled with zinc vitriol solution. Now, since a difference of five millionths of a second might be distinctly perceived, it is thus proved that the velocity of electricity in liquids must be *over* 800 geographical miles per second. As the conductivity of copper is at least 200 million times greater than that of the zinc vitriol solution, the velocity of electricity in copper must be at least 160,000 geographical miles if the specific conductivity were synonymous with the velocity of electricity.

From experiments with longer telegraph lines it appeared that the propagation of electricity in conductors occurs with a determinate velocity independent of the length of the conductor; this is, in iron wires, between 30,000 and 35,000 geographical miles per second. (The length of the line was in one case 25·36 kilometres, in others 23·37 and 7·35 kilometres.)

M. Siemens proposes to make similar experiments with a copper circuit in order to decide, by direct experiment, the question whether the velocity of electricity depends on the nature of the metallic conductor or not. From the experiments made with the caoutchouc tube filled with zinc vitriol solution, he considers the latter the more probable. We may further remark that Prof. Kirchhoff (in establishing Weber's fundamental law for the motion of electricity) already previously obtained the number, 21,000 miles, for the velocity of electricity in conductors, and at the same time came to the result, that this velocity must be equally great in all conductors. Siemens's measurements come much nearer to Kirchhoff's values than to that obtained by Wheatstone, viz., 61,900 geographical miles. S. W.

GERMAN EXPEDITION TO SIBERIA

AS a sketch of the present state of Central and Northern Asia, it may perhaps not be uninteresting to our readers to have laid before them the following extract from a letter written by Dr. Finsch, who, together with Dr. Brehm and Count Waldburg-Zeil, is at present engaged in the scientific exploration of Southern Siberia, under the auspices of the German Arctic Society. The letter dates from Lepsa, near the Balkash-lake, May 13.

"We started for Lepsa on May 3, and camped the first night in 'yurts'—tents—ready for us at the foot of the Arkat Mountains. The yurt destined for our own use was splendidly decorated [for, thanks to the orders of the Czar, the travellers found at each station everything requisite for their comfort and the prosecution of their journey ready for them; in addition they were always accompanied by a picket of Cossacks, who had to provide horses for them, and to see them safely from station to station.]

"Many Kirghiz chiefs, dressed in their picturesque attire, were awaiting our arrival, and we found a repast of pillaf, lamb, and kumis, ready for us. The Arkat Mountains are a mass of

bare, grotesque-looking rocks of granite, about 1,000 feet high. It is a solemn sight to see them gradually rise before your eyes out of the vast treeless steppe. Numbers of Argali were seen running on the mountains, and we proposed for the next day an Argali-hunt. The hunting party offered a strange picture on the next morning; there were fifty Kirghiz chiefs on horseback, many of them holding golden eagles on their hands. These birds are trained here to catch the wolf and the fox, and they acquit themselves excellently of their task, except in spring, when, their minds being taken up by love-thoughts, they are unfit for work. It is wonderful to see how the Argali dash along the rocks, and the young ones as quick, or perhaps still quicker, than the others. Several Argali and Argali kids were killed; we saw also a wolf, but failed to kill him. On the next day was a race of the Kirghiz boys; they rode 20 versts in 54 minutes. After that there was a wrestling match. The Kirghiz formed two divisions, each having its champion, who, dressed in shirt and drawers, was ready for the match. They stood with their shoulders together, and tried to throw each other down by seizing each other's girdle. The combatants were fine, muscular fellows. They showed also some equestrian feats, such as riding at full gallop standing. At about seven o'clock we continued our journey, and arrived the next morning in Sergiopol, formerly called Ajacus, a small town of about 1,000 inhabitants. The road to Sergiopol leads altogether through the steppe, which from time to time is covered with small mountain-ranges; on the last station before Sergiopol we saw for the first time the snowy tops of the Targabatai.

"Interspersed everywhere through the steppe are the yurts and peculiar tombs of the Kirghiz, whose herds wandering over the steppe help to animate it. The town lies in a treeless plain; before reaching it we were received by a picket of Cossacks in their gala-uniform, who conducted us to our quarters. Here we were welcomed by the district chief, Col. Friedrichs, who for ten days had awaited us in Sergiopol. Here we obtained some fine specimens of fishes from the Balkhash-lake, and we continued our road accompanied by Mr. Paul, a German telegraph official, and the commander of the town, Major Politzky. The line of Cossacks is here at an end. From time to time there is a miserable mud hut called "picket," where Cossacks ought to be. Horses are generally to be had there, vehicles but seldom. Our road led us always through the steppe, which began to show a white salty incrustation, and which everywhere is bordered in the most picturesque manner by the Tarbagatai. All along the road we were accompanied by Cossacks and chiefs of the Kirghiz. We took our first station on the banks of the Karakol, where we had a splendid view of the Tarbagatai and the more distant snowy heights of the Ala Tau, in the south. Here we found new specimens of the fauna of the steppe; the sandpiper, the eastern turtledove (*Turtur gelastes*), the white-throated lark of the Alps, the grey-headed wagtail. During the night we heard a strange cry, and found it to proceed from a frog, of which we obtained a specimen. Beetles were very scarce in the steppe, nor did we see any butterflies; perhaps it was still too cold. Our tea gets worse and worse, as now the water contains more and more salt; our principal beverage is, therefore, kumis, which, after all, is not so bad; it tastes a little sour, like buttermilk, and has a strange smell and after-taste. The major and Mr. Paul remained behind in Karakol, and so did our baggage cart, therefore our baggage had now to be carried by three camels. Behind Karakol are the first Kirghiz who cultivate the soil; they grow wheat in vast fields, irrigating them by damming the river, and turning over the fertile soil with a miserable plough that penetrates only to a depth of a few inches. The labourers were surrounded by numbers of *Larus ridibundus*. The first 12-15 versts we had to ride, because, from this forward, only the wild horses of the steppe were to be had, which up to this time had never seen a vehicle. It was most interesting to see the wild animals harnessed to the tarantassa; five fellows had at times enough to do to hold a single horse, and then off we went with shouts and blows, away like the wild huntsman in the story-book. As long as the vehicle held together everything went on well, but very often traces and reins broke at the first start. The steppe is covered with rhubarb, hemlock, and spiræa just beginning to flower. Where the alkali earth begins the ground was bare, and the plants which grew there had a grey, sombre colour. We saw sometimes the great and little bustard, also many kites, and here and there a golden eagle—kulans (wild horses) and antelopes (saigas) were not seen. On May 8 we entered upon the genuine salt steppe, and our horses sank up to their fetlocks in soil covered with a crust of white salt. The dust was awful; our way led through immense beds of reeds, and we found ourselves most probably in the dry bed of the lake Ala Kul. At night we reached the banks of the actual lake from the west side. At first there is nothing but a dense mass of reeds, only here and there is a narrow strait visible. Many geese, ducks, and swans were heard; we obtained here a specimen of the land tortoise. The next day we continued our road on the south side. It was very hot, and splendid mirages were dancing in the air; our way led continually through the salt steppe; the lake was mostly covered by reeds; only at two places was it to be seen. In the afternoon we reached a camp of yurts situated at the foot of a hill on the south side of the lake. The scenery before us was splendid; in the foreground the vast surface of the lake of a greyish blue bordered in the background by the Tarbagatai, and behind it rose the snowy summits of the Ala Tau. Numbers of birds are at the lake, innumerable grey geese with their young ones, ducks, swans, grey cranes, gulls, amongst these the beautiful grey fisher-gull (*Larus ichthyaetus*). The waterfowl were unfortunately very shy and scarcely to be approached. Near the lake on the steppe we found for the first time rose-starlings (*Rosenstaare*) and black-headed wagtails, amongst these some with white eye stripes, and a peculiar lark. We did not obtain any specimen of the reed-pipers, because shooting was impossible among the dense reeds. I got all the Kirghiz to help me to collect, and so we obtained beetles and two varieties of lizard, one most interesting, a kind of gecko, with pink and blue spots. It was very hot, 79° F. in the shade, and many gnats appeared. After having made a small raft out of the trunks of trees, we went fishing and caught many fishes, but only three to four varieties, all unknown to me, most interesting, and by no means belonging to the European kinds, with the exception of a sort of Cobitis. There was a peculiar fish about 2 feet long called Marinka, and said to be poisonous, but we tasted it and found it quite palatable. For two days we remained near the lake, living in a yurt belonging to the Sultan Abul Dair, who traces his pedigree from Jenghis Khan, and belongs to the "nobility of the white bone"; he possesses 2,000 yurts in his dominions. We collected many plants and some snails near the Ala Kul, and took samples of the soil, salt and water. We continued our road, passing through the steppe, onward to the Ala Tau, at the foot of which we took a night's rest in a yurt, whence we saw many Kirghisian tombs of unburnt bricks. The next day we were obliged to ride, because one of the horses objected altogether to be harnessed, and the others ran away with the vehicle. After some time, however, they became quieter, and we could again get into the vehicle. Meanwhile, the temperature had changed; it was very chilly; we were cold in spite of the furs, and happy to reach another yurt camp at about midnight. The road was scarcely perceptible; the Cossacks had to hold the carriage with ropes, and we heard continually the cry of "derschdi," *i.e.* hold fast. Dr. Brehm had an upset. On the next morning our road led through the green steppe interspersed with many "Auls" of the Kirghiz, whose herds, consisting chiefly of goats and fat-tailed sheep, were pasturing here and there. In the south the steppe was bordered by green hillocks, with masses of red outcropping rocks; in the west by bare sand hills, in the north and east by a higher range of mountains, covered with fresh-fallen snow, behind which rose the high summits of the Ala Tau. And on we went more into the mountains. We passed over the river Dschindschilla, where red bole is to be found, and then on without interruption through ravines and over mountains, on through the green but treeless landscape. We collected magnificent wild, red peonies, blue campanulas, and other plants; and here we saw for the first time the bee-eater. At length we saw Lepsa before us in the plain, surrounded by green but bare mountains; except in the south where they were covered with trees, behind which rose the picturesque peaks and cones of the Ala Tau, half their height covered with snow. Lepsa has nearly 3,000 inhabitants, consisting mostly of Cossacks and Tartars. Some Kirghiz live near. Broad streets planted with birch trees run through the town and give it a pleasant appearance. The houses are nearly all small and built of wood. Besides the Cossacks there is a regular battery stationed there. The town was founded since the conquest of Turkestan, and is growing rapidly. The Cossacks cultivate the ground and keep bees; the honey is very fine, and cuts like lard. We live very comfortably in the house of a rich Cossack, who possesses 2,000 hives, and only regret that we have to leave so soon."

NOTES

Mr. J. W. Judd has been appointed Professor of Geology in the Royal School of Mines in succession to Prof. Ramsay, who resigned some time since. Mr. Judd has been a frequent contributor to our pages, and his already distinguished work in the field of original geological research ... His appointment as Prof. Ramsay's successor must give universal satisfaction.

Prof. Ramsay has been called away to Gibraltar to report on the water supply there, his place as a lecturer at the British Association will be taken by Prof. Geikie.

Mr. Johann Pomner, a most promising young physicist, died in New York on June 11, aged 25 years. In the Polytechnic Institutes of Troy and Hoboken, he had thus early developed a very remarkable genius in the department of applied science. His studies had led him, with great success, into original investigations of heat as a force in nature, and his thorough, accurate and independent researches in this direction had attracted the favourable notice of the faculties under whom he studied. He attained to such important results as were found worthy of public notice, and he was engaged in the preparation and publication of an original work on the Dynamics of Heat, with the approval of his professors. His enthusiasm drank up his spirits, and utterly exhausted his physical force. Before he was aware, he was in the advanced stage of an incurable disease, and while labouring to put his work through the press at Cambridge he was prematurely ... His very rare attainments and his extraordinary ... research, had been brought to the notice of the ... University at Baltimore, and the day after his death only too late for his noble ambition came the certificate from the head of the university appointing him to a fellowship in that institution. As a lecturer in the department of his special and successful study he had become familiar with the best French and German works in modern science, and his accuracy, and perseverance, and thirst for knowledge, gave him promise of a very eminent future. We believe that there is good ground for hoping that Mr. Pomner's work on thermodynamics may be found to have been sufficiently advanced before his death to be still a valuable contribution to science. A very touching letter from a relative states that "he begged his physicians to keep him alive just to finish his book, and then he would be willing to go."

The British and the Cambrian Archæological Associations held their Annual Congresses last week, the former in Cornwall and the latter in South Wales. The members of the former were occupied mainly with visits to the various architectural remains in which Cornwall is so rich, and especially to the localities which are identified with the Arthurian legends. Mr. W. C. Borlase exhibited on Sunday afternoon to a large number of the members, his valuable collection of objects of prehistoric and antiquarian interest. On Monday a visit was paid to St. Just, in the neighbourhood of Land's End, and on the road thither, a number of Cromlechs and an old hill castle were visited. The meeting, during which a considerable number of antiquarian papers were read, was brought to a close on Tuesday. In the latter, which was opened at Abergavenny, the President was Dr. E. A. Freeman, who gave a valuable address on the importance of Welsh history, referring to the fact that there is no really good history of Wales, and urging upon the Association the advisability of a competent member at once undertaking to supply the want. The members visited several places in the neighbourhood of architectural interest. Both Congresses seem to have been successful.

There seems to be some doubt about the Social Science Congress meeting this year in Liverpool, on account of the difficulty in finding a building large enough to contain the many objects which it is intended to exhibit.

The Statistical Congress opens at Buda-Pesth on Sept. 1. A Congress of Archæology and Anthropology will also be held at ... the middle of the month of September. A proposition will be discussed for making the French language the only one to be used at such international meetings.

The 25th meeting of the American Association for the Advancement of Science commenced at Buffalo, N.Y., yesterday.

The University of Upsal, Sweden, will, say the *Academy*, celebrate next year, in September, the 400th anniversary of its foundation.

The Madrid *Correo* ... states that the Spanish Government has appointed a commission to inquire into the situation and the resources of the Philippine Islands. A botanist will accompany the expedition for the purpose of reporting on the nature of the flora of the interior and the extent of the forests, &c. The Commission will explore carefully the whole group, in order to prepare a map on a large scale. The mountain chains will be the object of special investigation; the heights of all the salient points will be determined with the greatest precision. The officers of the expedition will take notes and make observations for the purpose of preparing a complete monograph of all the islands explored.

The number of visitors to the Loan Collection of Scientific Apparatus during the week ending August 19 was as follows:—Monday, 2,710; Tuesday, 2,180; Wednesday, ...50; Thursday, 270; Friday, 2,8...; Saturday, ...,250; total, 8,918.

Mr. L. A. Dillon, writing to Tuesday's *Times* in reference to the proposal to tow up the *Vanguard*, shows that such a course would be quite wanton. He states that he has proved by varied and practical experiment, that by covering the ship tightly with a sheet of canvas a ... would be formed, from which air pumps could easily expel the water, and the ship would recover her buoyancy and instantly rise and float. Judging from the experiment described by Mr. Dillon the attempt ought to be made, and that, too, with the greatest hope of success.

A General Meeting of the Mineralogical Society of Great Britain and Ireland will be held at Glasgow on the afternoon of Wednesday, Sept. 6, after the meeting of the General Committee of the British Association. The exact time and place will be posted up in the British Association Reception Rooms. The chair will be taken by Prof. M. Forster Heddle, M.D., F.R.G.S. All papers intended to be read should be forwarded to Mr. J. H. Collins, at 57, Lemon Street, Truro, Cornwall, not later than Saturday, Sept. 2.

From the Report of the Manchester and Salford Sanitary Association for 1875, we observe that this influential body continues in full activity the good work it has long done in promoting public interests. The pollution of rivers, hospital accommodation, and the control of noxious vapours, are some of the subjects affecting the public health which have occupied the Association during the year. Three of the winter lectures, viz., those on the causes reducing the effects of sanitary reform, on the preservation of health, and on the seeds of disease, have been published at a penny each, and tracts on such subjects as typhoid and scarlet fevers, vaccination, personal cleanliness, clothing, houses, and the feeding, clothing, and nursing of children, have been distributed to a large extent. But what distinguishes this from all other similar societies are the returns of disease in public practice which are published weekly, no other statistics of the kind being published in the kingdom. We earnestly hope that the Association will soon be in a position to discuss the invaluable material they have now accumulated under this head, and publish the results in the form of weekly averages for the different diseases, since the important question of the relation of

weather to health cannot be satisfactorily handled, unless not only the number of deaths, but also the number of attacks, be known.

IN the *Hansa* for July 23, at p. 143, appears the first of what promises to be an interesting series of articles by Captain Niejahr on the relation between the formation of clouds and the direction of the wind on the coasts of Northern China and Japan, between 28° and 42°, lat. N., and 121° and 142° long. E.—a region peculiarly suitable for this practical inquiry, inasmuch as it lies between the continent of Asia and the expanse of the Pacific, and its southern portion is besides within the region of the N.E. trade. Attention is more particularly drawn in this article to two distinct kinds of cumulus which suddenly appear in the form of a massive bank of clouds in the western horizon, and are rapidly dissolved as they drift eastward, disappearing before they sink to the eastern horizon, often even before they reach the zenith. These two kinds of cumulus, distinguished as wind-cloud and simple cumulus, differ in their outlines, consistency, and height, in the direction of their motion and the mode of their formation, and there can be no doubt that thorough investigation of them would result in no inconsiderable advantage to navigation. We look forward with much interest for the continuation of this discussion in future numbers of the *Hansa*.

THE Municipal Council of Paris has established a certificate for the pupils of municipal schools; the examinations are proceeding now at Luxembourg. The number of candidates is about 4,000.

IN consequence of the appointment of Mr. L. C. Miall to the Professorship of Biology in the Yorkshire College of Science, the office of Assistant-Secretary to the Leeds Philosophical and Literary Society is now vacant. Mr. R. Reynolds, the Honorary Secretary of the Society, will, we believe, give every information to candidates for the post. Prof. Miall will still continue to act as general curator of the museum.

IN connection with the general introduction of the now celebrated Liberian coffee plants into most of the coffee-producing countries, as noticed by Dr. Hooker in his recently issued report on Kew Gardens, we may draw attention to what our consul says on the decrease of the production of coffee in Cayenne. The kind there cultivated is the Mocha, which at one time was an important staple of the colony, the country being especially adapted for its cultivation. This valuable product of Cayenne, although temporarily abandoned, is not lost to the world; the trees continue to thrive in a wild state, and may be reclaimed hereafter. There are thousands of coffee trees interspersed in the forests of the inhabitable part of the colony which have been abandoned for years. They attain a height of about fifteen or sixteen feet, with a circumference, a few feet from the ground, of thirty inches; they are rich in foliage, but do not bloom. The coffee tree also appears to be safe from the ravages of insects, whereas many other trees suffer vitally from this evil.

THE *Ergebnisse der Beobachtungsstationen an den deutschen Küsten*, 1875, published monthly, have been received. In their researches into the physical peculiarities and fisheries of the North and Baltic Seas, the Ministerial Commission at Kiel continue to carry out with vigour and ability the comprehensive system of observation established by them a few years ago, under which the physical data necessary for the solution of many questions affecting the fisheries of these seas are being gradually accumulated. These include physical observations at nineteen stations on the daily height of the water of the seas, their temperature, specific gravity, and currents, and the amount of cloud and direction and force of the wind; very full meteorological observations at four stations; and the details of the daily fishings in each of the seven districts of the coasts. It might be suggested whether observations of daily maxima and minima of the temperature of the sea by thermometers continuously immersed, as suggested by Mr. Stevenson, and carried out by the Scottish Meteorological Society in similar inquiries, might not, from their great practical value, be added to their physical observations by the Commission at Kiel.

AN account of the geology, physical geography, and botany of the West Riding of Yorkshire, is now in course of preparation, and will shortly be published by subscription. The geological portion of the work will be undertaken by Mr. J. W. Davis, F.G.S.; Mr. F. Arnold Lees, F.L.S., will be responsible for the botany, while the division of physical geography will be a joint production of the two authors. In this last section, with the description of each locality, the flora of each area will be given. We believe Mr. J. W. Davis, of Greetland, Halifax, will furnish particulars and receive subscriptions.

THE Mayor of Marseilles and the Prefect of Bouches du Rhone have signed a contract obliging the city to pay a yearly subvention of 15,000 francs to the Observatory, and to continue *in perpetuo* the free grant of lands and buildings in the present site occupied by it. M. Waddington will ask the Budget Commission for an enlarged credit.

WE are glad to notice the advent of a new Norwegian journal of science published at Christiania, and entitled *Archiv for Mathematik og Naturvidenskab*, the editor being M. Albert Cammermeyer. The following are some of the articles contained in the first two numbers:—"On the Ancient Norwegian Coasts," by M. Sexe; "On the Fjords and Glaciers of Northern Greenland," by Amund Helland, who visited this country during the months of June, July, and August, 1875; a review by Worm Muller, of Malassez's "La Numération des Globules Rouges du Sang." Besides these there are other papers on Geology and Meteorology. We wish every success to this new periodical.

THE proposal to submerge a portion of North Africa by means of a canal from the Gulf of Gabes, letting the water of the Mediterranean westwards over the lake region of Djerid, seems from the facts detailed by MM. Roudaire and Dupuis to be not only a practicable, but also likely to turn out a remunerative undertaking. Owing to the comparatively small area it is proposed to submerge, the meteorological changes which the submersion would occasion can only be slight, strictly local, and altogether beneficial in their general tendency—differing absolutely in all these respects from the meteorological changes which would result from the submersion of the western portion of the Sahara, proposed some time ago. From this latter project it would follow, owing to the great extent of the water surface which would thus overspread the Western Sahara, and its proximity to the Atlantic, that the present disposition of the lines of atmospheric pressure would be seriously altered, a result necessarily attended with changes in the prevailing winds and currents of the North Atlantic, seriously affecting international interests in a manner which our present knowledge does not enable us in any way accurately to predict. But such an objection does not apply, as already stated, to the project of submerging the region of Djerid.

THE law for the International French Exhibition for 1878 has been voted by the Senate. M. Krantz, the director, an engineer, has established his offices at the Palais de l'Industrie, and sixteen pupils of the School of Beaux Arts are executing building plans under his direction. The work of construction in the Champ de Mars is expected to begin almost immediately.

ON July 26 the shock of an earthquake was felt at Grenada, the direction of the oscillations being north to south. As the

duration was only a few seconds no real damage has been recorded.

An interesting series of papers is commenced in the August part of the *Geographical Magazine*, giving Sketches of Life in Greenland, by a lady who was born and passed several years of her life in the country. The papers are likely to show life in Greenland in somewhat new aspects. In the same number is a long and valuable letter from Dr. Beccari on New Guinea, dealing chiefly with its ethnology; he holds firmly to the opinion that the Papuans are a mixed people. Mr. H. P. Malet contributes a paper on the Sea-Level, and Mr. Ravenstein continues his paper on the Census of the British Isles.

In the last issued number (May) of the *Bulletin* of the French Geographical Society, is a long and valuable Report on the Progress of the Geographical Sciences during the year 1875, by M. Ch. Maunoir. In the same number is the conclusion of M. De Sainte-Marie's Itinerary in Herzegovina, and the address of the President, Baron De La Roncière Le Noury, at the last general meeting of the society.

The "concours general," or competition between the pupils of the several colleges of Paris, is an old institution established by the University of Paris about thirty years before the French revolution. In 1730 a Parisian *bourgeois*, called Legendre, bequeathed to the University a large sum of money under that condition. The University was put in possession only after a long law-suit instituted by the heirs, who urged insanity, but at last were defeated. A number of celebrated *littérateurs* have been successful candidates. This year the *prix d'honneur* was taken by young Remach, who for the first time since the "concours general" was established, took all the other prizes of his class. The success of the "concours general" for the colleges of Paris was so large that M. Duruy established in the last years of the Empire a competition for all provincial colleges, Paris and Versailles excepted. This year the most successful college was Grenoble, which took eight nominations. Lyons took only seven.

Some interesting particulars of the great rains which occurred in the north-east of Switzerland in the middle of June last are communicated by M. F. Zurcher to the *Bulletin Hebdomadaire* of the Scientific Association of France. From 8 P.M. of the 13th to the morning of the 14th the enormous quantity of 12·4 inches of rain fell at Zurich—a quantity greater than any monthly fall since the observations began in the end of 1863, the largest monthly rainfall having been 11·3 inches during March, 1876. Owing to so unprecedentedly large a rainfall and the melting of the snows which occurred at the same time, Lake Constance rose nearly 10 feet above its usual level. It may also be noted that heavy rains have prevailed since the beginning of February, so much so that on the morning of June 14, the amount collected, reckoned from the beginning of the year, was 45·67 inches, being nearly 2 inches above the annual average rainfall of Zurich. Whence came the aqueous vapour which was discharged from the clouds in such deluges of rain on the night of June 13-14?

In the same number of the *Bulletin Hebdomadaire* it is stated that Dr. Grzygmala, of Podolia, in East Russia, where hydrophobia is very prevalent, has successively treated, without a single failure, more than a hundred cases of hydrophobia with the leaves of *Xanthium spinosum*. It is necessary that the remedy be applied shortly after the person has been bitten and before the symptoms of hydrophobia become manifest—the treatment consisting of 9¼ grains of the leaves of *Xanthium* in the form of a powder, thrice a day for three weeks. For animals the treatment is the same except that the dose is larger.

The additions to the Zoological Society's Gardens during the past week include a Spotted Eagle (*Aquila nævia*), European, presented by Mr. W. Prodham; two Common Barn Owls (*Strix flammea*), European, presented by Miss M. A. Hicks; a Yellow-bellied Liothrix (*Liothrix luteus*) from India, presented by Mr. W. Prehn; a Common Cuckoo (*Cuculus canorus*), European, presented by Mr. J. Paddy; an Egyptian Vulture (*Neophron percnopterus*) from North Africa, deposited; two White-crested Laughing Thrushes (*Garrulax leucolophus*) from the Himalayas, a Sun Bittern (*Eurypyga helias*) from South America; a Hawk's-billed Turtle (*Chelone imbricata*) from the West Indies, purchased.

SCIENTIFIC SERIALS

American Journal of Science and Arts, July.—Prof. Loomis here gives some interesting results obtained from observations of the United States Signal Service. Whenever an area of low barometer is formed in the United States, there seems to be always an area of high barometer about 1,200 miles to the south-east. The same thing was found to hold for the Atlantic Ocean and Europe, the average distance between the areas being here 1,700 miles, and the direction rather more southerly. Areas of high pressure are probably formed from air that is expelled from those of low. Low barometer is generally associated with high temperature, so we might conclude that a temperature above the mean in Iceland would be accompanied by one below the mean in Central Europe; this was verified. An unusually high barometer in Central North America may be the result of storms 1,500 or 2,000 miles to the north-west. Prof. Loomis found the average forms of the isobars about an area of maximum pressure, an oval with major axis nearly double the minor. The forms about minima were nearly the same; as were also the directions of the major axes in both cases (N.E.). The rainfall is least when the pressure at the centre of a storm is increasing (or the storm diminishing in intensity), greatest in the opposite case. The stationariness for several days of storms near Nova Scotia or Newfoundland, seems due to unusual rainfall there. Prof. Loomis lastly furnishes data as to the course and velocity of storms in tropical regions.—Prof. Farlow has studied a disease which caused much loss of olive and orange crop, in California last summer. He says that though first attracting the eye by the presence of a black fungus, the disease is not caused by it, but rather by the attack of some insect, which deposits some gummy substance on the leaves and bark, or so wounds the tree as to cause some sticky exudation on which the fungus especially thrives. The fungus greatly aggravates the trouble, but in seeking a remedy, it is necessary to look further back.—Mr. Gilbert gives a description of the Colorado Plateau Province as a field for geological study; it offers valuable matter in an advantageous manner.—Drs. Blake and Genth describe a vanadium mica found on the western slope of the Sierra Nevada, and to which the name of Roscoelite is given, in honour of Prof. Roscoe. It contains quite a large per-centage of vanadium (20·16), which is present as V_6O_{11}. This mica is found in the hanging wall of a small quartz vein, the country rock being porphyry; fine scales of gold occur between the crystals.—We may further mention a series of notices of recent American earthquakes (1874-76), by Prof. Rockwood.—Mr. Grinnell describes, in the Appendix, a Crinoid from the Cretaceous formation of the West.

Poggendorff's Annalen der Physik und Chemie, No. 5, 1876.—In this number we have the first portions of two valuable papers on electrical subjects—one by M. Root on dielectric polarisation, the other by M. Wiedemann, on the laws of passage of electricity through gases. We shall return to these.—M. Edlund passes under review some researches on what he had termed *galvanic expansion*; confirming and extending the observations of Streintz in reply to objections urged by Wiedemann against the results from which M. Edlund inferred that there was such expansion (distinguishable from that by heat). From the fact that it disappears pretty much according to the same laws as heat, the author and M. Streintz supposed that it was caused by molecular oscillations which are gradually communicated to the surrounding medium; and anything furthering this communication must so diminish said expansion. Now, M. Exner lately experimented by keeping the wire through which the current was sent, in cold water; and the result was an entire disappearance of galvanic expansion, as might have been expected, but the phenomenon was not thereby proved (as M. Exner thought) to have no existence.—In

experimenting as to the influence of current strength, temperature and concentration of solution, on the transference of ions, M. Kirmis met with a peculiar regular arrangement of silver crystals in the platina dish of a silver voltameter. The result is best obtained with a considerable electromotive force. The intensity should not exceed a certain limit (not more than 0·28 mgr. of silver being separated out per square ctm. and minute). The concentration of the solution should be between 5 and 10 per cent., and a positive electrode with sharp points should be used. The deposited strips appear as accumulations of moss-like dendrites, which, under the microscope, are found to be made up of cubes and octahedra.—In works which describe the process that occurs in sounding an open or closed pipe, it is usually represented that the air current from the slit at the bottom, breaking against the upper lip, imparts shocks to the air column of the pipe, and these are the cause of the air-column being thrown into vibrations. M. Sonreck, an organ-maker of Cologne, here questions this hypothesis, and supposes instead a pendulum-like to and fro motion of the blast-current, which has the widest amplitude at the edge of the upper lip, is dependent on the elasticity of the air-column of the pipe and the pressure of the outer air, and so is subject to the laws of vibration of the air-column. He explains the process in some detail, and some interesting forms of experiment are described. For complete determination of any colour it is necessary to know three things, viz., the colour-tone, purity, and brightness. The first is found by ascertaining that spectral colour by whose mixture with white the colour in question is had. M. von Bezold describes two methods of doing so simply and without trouble. They are closely related to a plan suggested by Vierordt for producing mixtures of pigment and spectral colours.—M. Gieseler describes a simple apparatus for measuring small intervals of time by a determination of the time of fall of a freely-falling body.—We further note papers on the specific heat of cerium, lanthanum, and didymium, by M. Hillebrand; and on experiments on the electro-motive forces induced in unclosed circuits through motion, by M. Helmholtz.

THE current number of the *Ibis* commences with a paper by Prof. Newton and Mr. Edward Newton on the Psittaci of the Mascarene Islands, in which the Seychellian *Palæornis wardi* is figured, and the species peculiar to each of the islands are described, four of the eight being extinct, one barely surviving, and the remainder diminishing in number. Mr. H. Seebohm and Mr. J. A. Harvie Brown continue their notes on the birds of the Lower Petchora, figuring the eggs of *Tringa minuta* from Dvoinik.—Mr. D. G. Elliot in his notes on the Trochilidæ discusses the genera *Cynanthus* and *Heliotrypha*, describing seven species of the former, one, *C. microrhyncha*, being new, and three of the latter, *H. squamigularis*, of Gould, being shown to be *H. barrali*, of Mulsant and Verreaux. -Mr. H. E. Dresser continues his notes on Severtzoff's "Fauna of Turkestan," specially referring to *Ciconia mycteriarhyncha*, a species with the bill shaped like that of *C. boyciana*, but red.—Mr. R. Swinhoe describes a collection of birds from Hakodadi, in Northern Japan, sent by Mr. T. W. Blakiston. Two new species are described and figured, *Arundinax blakistoni* and *Schœniclus pyrrhulinus*.—Lord Walden makes notes on the late Colonel Tickell's manuscript work entitled "Illustrations of Indian Ornithology." The work was presented by the author in 1874 to the Zoological Society. It is beautifully illustrated and fully annotated, forming seven small folio volumes. Figures are given of *Picus atratus*, *Zosterops siamensis*, and *Dicæum trigonostigma*, together with a brief account of the contents of each volume.—Mr. P. L. Sclater records further ornithological news from New Guinea, describing results arrived at by Beccari, Bruijn, and D'Albertis. The collections of the two first named contain 4,600 specimens, referable to 350 species, of which 58 are said to be new to science.—Mr. J. H. Gurney continues his criticism of Mr. Sharpe's "Catalogue of the Accipitres in the British Museum."—Lord Walden describes and figures a new species of *Trichostoma* from Celebes, *T. finschi*, and finally Mr. Salvin describes a new *Odontophorus*, *O. cinctus*.

Geological Magazine, Nos. 141, 142, 143, 144, 145.—The articles that are running through several numbers are: -Sketch of the geology of Ice and Bell Sounds, Spitzbergen, by Prof. A. E. Nordenskjöld, with woodcuts.—The probable conditions of deposit of the Palæozoic rocks in the northern hemisphere, by Henry Hicks, with a folding plate comparing Europe with North America—Cretaceous Gasteropoda, by J. Starkie ... There are several papers on glaciers and ice-action: among them are Mechanics of Glaciers, David Burns.—Ice-work in Newfoundland, John Milne (of the Mining School, Japan).—Glacial events in England and Wales, D. Mackintosh.—The erosion of lake-basins by glaciers, Osmond Fisher.—Notes on glaciers, T. G. Bonney.—Sub-aerial denudation *versus* glacial erosion, W. Gunn.—There are also many letters on the subject of the origin of lake-basins from Prof. Ramsay, James Geikie, Prof. Hull, Prof. Green, J. W. Judd, T. V. Holmes, Hugh Miller.—The other papers are: On the Carrara marbles, by G. A. Lebour, showing why they are now regarded as of Carboniferous age instead of Jurassic, as recently they have been.—The transport of volcanic dust, by Prof. Nordenskjold. This is a record of the passage of volcanic dust from Iceland to the east coast of Sweden, a greater distance than has ever been known before.- A paper on the vertical range of graptolites in Sweden, by G. Linnarsson, is accompanied by one on the correlation of the graptolitic deposits of Sweden with those of Britain, by Prof. H. A. Nicholson.—On the exhumation and development of *Omosaurus armatus*, Owen, by W. Davies, of the British Museum. This is a popular description of how the remains were removed from the Kimmeridge clay of Swindon to the British Museum.—On the volcanic outbursts which preceded the formation of the Alpine system, by J. W. Judd.—In connection with Mr. Hick's papers on Palæozoic rocks is one by Prof. Linnarsson, criticising some of his conclusions.—There are also some minor papers and a number of miscellaneous articles.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, Feb. 3.—Contributions to a knowledge of interstitial inflammation of the liver, by M. Muller.—On the ending of nerves in the epidermis of mammals, by M. Mojsisovics. He examined (after Eimer) the snout of the mole, and of some foreign related species; and he comes to a different conclusion regarding the "Eimer organs." M. Riegler exhibited an osteophyte, weighing 1,120 gr., that had been found in the skull of an ox. The animal had seemed quite fresh and healthy.

Feb. 10.- On the colours of thin crystal plates, by M. Ditscheiner. These arise through interference of the internally reflected light rays, and are seen in crystal plates (gypsum) of much greater thickness than that which simply refracting plates must have in order to show the ordinary colours of thin plates.—On the changes in arterial blood pressure after closure of all the arteries of the brain, by M. Mayer. There is at first great increase of arterial blood pressure, which is not due either to the mechanical closure, nor to increased activity of the heart, but to intensive stimulation of the cerebral vasomotor centre, through deficient access of arterial blood. In five or ten minutes this excited state of the brain centre passes into that of complete paralysis, indicated by low blood pressure. The author draws some inferences for the doctrine of the vasomotor centres in the brain and spinal cord.

GENEVA

Physical and Natural History Society, March 16.—Prof. Plantamour, fifteen years ago, gave a *résumé* of the results of the meteorological observations made at Geneva since 1826. Disposing, to-day, of fifty years' observations, he examined the modifications made on his conclusions by that new period of fifteen years, and other results which may be deduced. The mean of temperature has been in general greater during the last fifteen years, and enables us to increase by $\frac{1}{10}$ of a degree the annual mean previously deduced. All the monthly means must be slightly augmented, if they are to be derived from fifty years of observation instead of thirty-five; except in the case of the month of December. The following is the table of means (in centigrade degrees) according to the two series:—

	Jan.	Feb.	Mar.	April	May	June	July	Aug.
1826–1860 ...	−0°·34	+1°·32	4°·48	8°·61	12°·88	16°·78	18°·53	17°·80
1826–1875 ...	−0·08	+1·00	4·60	8·97	13·20	16·81	18·81	17·91
Difference ...	+0·26	+0·[illegible]8	+0·12	+0·36	+0·32	+0·03	+0·28	+0·11

	Sept.	Oct.	Nov.	Dec.
1826–1860 ...	14°·29	9·81	4°·45	+0°·86
1826–1875 ...	14·66	9·88	4·55	+0·80
Difference ...	+0·37	+0·07	+0·10	+0·06

The same result appears if we divide the year into seventy-three periods of five days, or pentades, according to the

system of Dove. The comparison of the temperatures of the seventy-three pentades, observed and calculated by the formula, may serve for studying the question raised by M. Ch. St. Claire-Deville, viz., whether there exist certain days or certain epochs of the year when the temperature is lower or higher than is consistent with the regular progress, ascending or descending, of the said temperature. The greater the number of years on which this comparison is based, the more the difference between observation and calculation diminishes, not only absolutely, but in comparison with the mean error. This is contrary to the theory of M. St. Claire Deville, for if there existed a cause of errors at certain determined epochs, they ought to become more pronounced the greater the number of years. By calculating for each pentade the probable error, we may deduce from it the periodical formula representing the variability of the temperature at the various epochs, a variability which differs much in the various months. Thus it is about ± 2°·53 at the beginning of January, it diminishes to ± 1°·77 towards the end of March, rising to ± 1°·84 at the beginning of May; it falls again to ± 1°·38 at the beginning of October, and increases rapidly afterwards to the end of the year. The first days of May, dreaded for a return of cold, correspond closely to a period of very great variability; but these returns of cold do not take place at a fixed period; they may occur from the end of April to the end of June. In relation to the succession of warm years and cold years, there will be recognised incontestably in the fifty years of observations at Geneva, series in which the one or the other predominate in a striking manner. Thus between 1829 and 1834 we find seven warm and two cold years; between 1835 and 1860, twenty-two cold, and four warm years; during the fifteen last years, thirteen warm and two cold. But there is no trace of periodicity in this return of warm or cold years. By establishing four categories for the years, M. Plantamour has found that there has been during the period of half a century, fourteen very cold years, twelve cold, ten warm, and fourteen very warm. The denominations "very cold" and "very warm" are applied to negative and positive divergences surpassing the limit of probable divergence. These figures are very near to the probable figure 12·5 for each category. In the case of a periodic return of warm and cold series, every eleven years taken, for instance, as in the case of the solar spots, as some meteorologists have presumed, the succession of warm and very warm, cold and very cold years, ought to be the most common; on the other hand the succession of years very different in temperature ought to be very rare. But nothing of this kind has been observed; on the contrary, a very cold year may follow a very cold year, or *vice versâ*. It is then impossible to deduce any periodicity in the succession of cold and hot years.

PARIS

Academy of Sciences, Aug. 14.—Vice-Admiral Paris in the chair.—The following papers were read:—Experimental critique on glycæmia (continued). Glycæmia has its source in the glycogenesic function of the liver; by M. Cl. Bernard. 1. The blood of the sub-hepatic veins is more saccharine than the arterial blood and the blood of the *vena porta*. 2. The blood of the inferior *vena cava* is suddenly enriched in sugar (before entering the heart), at the part where the sub-hepatic veins join it. On the thermal formation of two isomeric propylic aldehydes, by M. Berthelot. The transformation of a primary and normal aldehyde into a secondary isomeric aldehyde liberates very little or no heat. Isomeric bodies of the same chemical function are formed with almost the same liberations of heat, and this similarity subsists in the formation of their isomeric derivatives.—Thermal researches on hydrosulphurous acid, by M. Berthelot. Systems are so much the more stable, other things equal, as they have lost a greater proportion of their energy.—On the dynamical theory of regulators, by M. Rolland.—On a hydrated aluminous silicate deposited by the hot spring of Saint-Honoré (Nièvre) since the Roman epoch, by M. Daubrée. This deposit is characterised by the great predominance of silica over alumina and the small quantity of water.—On trepanation of the bones in various forms of osteo-myelitis, by M. Ollier.—Results obtained in treatment of phylloxerised vines with sulpho-carbonates, by M. Marès. He applies to the attacked parts sulpho-carbonate of potassium (1 decilitre per stock) dissolved in water or absorbed in powdered soda-residuum, then hardens the ground by rolling or beating. This proves successful. It should be done before the stock has become stunted; otherwise two or three seasons' treatment may be necessary to recover it, or it may not recover.—Observations on the development and the migrations of Phylloxera, by M. Boiteau.—Employment of a distributing pale to convey sulpho-carbonates to the roots of phylloxerised vines, by M. Gueyraud. The sulpho-carbonates diluted with three or four times their volume of water and distributed at a depth of 25 cm. to 50 cm. destroyed in three days the Phylloxera on the roots, and restored vigour and verdure to the vines.—Treatment of phylloxerised vines at Aimargues (Gard). Employment of a subterranean projector for distribution of the insecticide liquid, by M. Roussellier. With this projector he applies sulphide of carbon, in very small doses, repeated all the summer, to the roots.—On the destruction of Phylloxera by means of decortication of the vine-stocks, by M. Sabaté. In thirty hectares of vines decorticated last winter, not only the old centres of infection had not extended, nor had new ones been formed, but many vines, thought to be gone, had recovered their vigour. In forty non-decorticated hectares, the reverse was the case. The process is accomplished easily with steel gloves.—Discovery of a planet (165), by Mr. Joseph Henry, at Washington, Aug. 10, by M. Leverrier.—Observations of the Perseides, at the Observatory of Clermont-Ferrand, on Aug. 10 and 11, by M. Gruey.—*Résumé* of practical rules of the new navigation, by M. Fasci.—Influence of sonorous vibrations on the radiometer, by M. Jeannel (see note). Action of hydracids on tellurous acid, by M. Ditte.—On thodeine from the analytic point of view, by M. Jacquemin. A drop of pure aniline, then of hypochlorite of soda, added to a certain volume of alcohol diluted with water, gives a yellowish colour, passing into green or persistent bluish green. This reaction should prove useful in testing for phenol.—Researches on the derivatives of acetylvalerianic ether, by M. Demarçay.—Examination of the minerals of Chili, by M. Domeyko.—Alterations of the urine in athrepsia of the newly-born; applications to diagnostic, prognostic, and pathogeny, by MM. Parrot and Robin. Investigation of animal organic matter in ancient strata, by M. Husson. From his comparisons he concludes:—1. That bitumens with tarry odour are of essentially vegetable origin. 2. That those with fetid odour, recalling Dippel oil, are of animal origin. 3. That these are, in secondary and tertiary strata, the last remains of the animal substance which is found already profoundly altered in the diluvium, and which exists in great part in the state of osseine in the ground of our bone-caverns.—Experiments on mechanical reproduction of the flight of a bird, by M. Tatin. He obtained much better effects with his mechanical birds (worked by caoutchouc springs) by always placing the centre of gravity before the centre of suspension.—Stratified beds of massive silex observed near Digoin (Saone-et-Loire) in a formation considered as cretaceous, by M. Canat.

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ERRATUM.—Vol. xiv. p. 338, col. 1, line 9 from bottom, for "Umbelliferæ" read "[illegible]"

THURSDAY, AUGUST 31, 1876

PHYSICAL SCIENCE IN SCHOOLS

AT a meeting of the British Association five years ago, the subject of science teaching in our higher schools excited unusual interest. Not only were papers read and followed by enthusiastic discussion, but a committee was privately formed, including more than twenty leaders of the association, all of whom undertook to combine in pressing the claims of science on our head-masters, and in offering counsel as to systems and methods, apparatus, and expenditure. Technical difficulties prevented the formal nomination of the committee in that year; and before the next meeting came round the Science Commission was in full work, and the ground was covered. Five years have passed; the Commission has reported; and the British Association, if it deal at all with the problem that lies at the root of our scientific progress, will have to face the fact that only ten endowed schools in England give as much as four hours a week to the study of science; in other words, that in spite of ten years of talk, the *éclat* of a Royal Commission, a complete consensus of scientific authority, and the loud demands of less educated but not less keen-sighted public opinion, the organisation and practical working of science in our higher schools has scarcely advanced a step since the Schools Inquiry Commission reported in 1868.

Are the causes of this strange paralysis discoverable, and are they capable of present remedy? We believe that they are notorious, and that it is in the power of the British Association at the present moment to overrule them. It is therefore in the hope of rekindling a productive enthusiasm at a critical moment in the history of our science teaching that we appeal with all the earnestness of which we are capable to the leaders of the great parliament, whose session will have opened before this day week.

The first obstacle to be understood and reckoned with, is the amazing confusion in the minds of unscientific leaders of opinion as to the very nature of education. An ex-Lord Chancellor gives away prizes to a school, declares in stately terms that Greek and Latin must always form the backbone of high intellectual training, and that the sciences can only be tolerated as a sort of ornament or capital to this great central vertebral column. On the following day an ex-Chancellor of the Exchequer gives away prizes at another school, assures the boys that modern scientific teaching is their being's end and aim, and envies them by comparison with himself, who at Winchester and Oxford basked only in the "clarum *antiquæ* lucis jubar." In all such public utterances chaos reigns supreme. Men take side with one or other branch of mental discipline, unconscious of the Nemesis which waits on the divorce of literature from science, or of science from literature, forgetful of the fundamental truths that all minds require general training up to a certain point, and that the period at which special education should supervene is the problem which awaits solution.

The hostility of the clergy ranks high among the difficulties we have to recognise. To the great public schools this is matter of indifference; but the vigorous head-master of a young and rising county school, who attempts, being himself a clergyman, to make real science compulsory in his school, is rattened by the vulgar heresy-hunters, who swarm in every diocese. The hint and shrug in society, the whisper at clerical conferences, the warning to parents attracted by the school against "atheistic tendencies," keep down his numbers and wear out his energies, till his enterprise becomes a warning instead of an example to his admirers at other schools. In a neighbourhood of rural squires and clergy, untempered by a large town's neighbourhood, and unchecked by any man of education and intelligence holding sovereignty by virtue of superior rank and wealth, a school which treads doggedly in the ancient paths and is flavoured with gentle "High Church tendencies," will certainly succeed even in second-rate hands, while a school which under superior chieftainship asserts the claims of science, and whose theology is therefore suspect, will as certainly long struggle for existence, if it does not finally succumb.

The head-masters, with no inveterate intention, but by the force of circumstances, are potent allies upon the side of nescience. Their position is peculiar. Enlightened, able, high-minded, and most laborious, to speak of them with disrespect would be to forfeit claim to a hearing. But of their whole number not more than two or three know anything at all of science; they have gained honours and supremacy by proficiency in other subjects; to teach well these subjects which they know, forms their happiness and satisfies their sense of duty; and they feel natural dismay at the proposal to force upon them new and untried work which they have not knowledge to supervise, and which must displace whole departments of classical study. Bifurcation they do not mind, for they hope that the dunces will be drafted into the modern school, and the clever boys retained upon the classical side; but the momentous recommendation of the Royal Commission that six hours a week of science teaching should be given to every boy in every school has taken away their breath; it was only once alluded to at the last head-masters' meeting, and then with something between a protest and a sneer. They are too clear-sighted not to see that the demand for science teaching is real, and too liberal not readily to accede to it, if some central authority, which they respect, at once puts pressure on them, and tenders such assistance and advice as they can trust. But, until these two things are done, they will pursue a policy of inaction.

Nor is there any hope that this reluctance of head-masters will be stimulated by exuberant energy on the part of governing bodies. The instances in which these pet creations of the Endowed Schools Commission have appeared before the public hitherto, make it evident that absolute inactivity is the service they are best calculated to render to the cause of education; but their probable devotion to science may be guessed from an incident reported in our columns some months ago, where a body of trustees, composed of country gentlemen of local mark, having to arrange a competitive examination under a scheme of the Charity Commission, adopted the machinery of the University Leaving Examination, but inserted a distinct proviso that no scientific subject recognised by the University Regulations should under any circum-

stances be taken up by the candidates, either as an alternative or a positive branch of work.

Will the Universities help or impede the spread of school science teaching? The Universities adhere at present to their fatal principle that only one-sided knowledge shall find favour within their walls. A boy who knows nothing but classics, nothing but mathematics, nothing but science, may easily win a scholarship; a boy who knows all three must seek distinction elsewhere; and this rule shapes inevitably the teaching of the schools. The science scholarships at Oxford, of which we hear so much, fall mainly to three distinguished schools; two so large and wealthy that they can overpower most competitors by their expenditure on staff and apparatus, the third planted in Oxford, with access to the University museum and laboratory, and with a pick of teachers from the men of whom examiners are made; and these schools ensure success in science by abandoning other subjects almost or altogether in the case of the candidates they send up. No school which should carry out the recommendations of the Commissioners, by giving six hours a week to science, and the rest of its time to literature and mathematics; no school which should realise its function as bound to develop young minds by strengthening in fair proportion all their faculties of imagination, reason, memory, and observation, could offer boys for any sort of scholarship under the present University system with the faintest chance of success.

What these institutions are powerful to avert or helpless to bring about is, we repeat, within the scope of the British Association to effect. All institutions, political or educational, will bow to a strongly formed committee of scientific men, formally commissioned by the Association and speaking with authority, delegated as well as personal, on scientific subjects. Let such a Committee be revived as died on paper in 1871, including the acknowledged leaders of pure science, and weighted with the names of such educationalists as have shown themselves zealous for science teaching. Let their functions be—first, to communicate with the head-masters and governing bodies, calling attention to the recommendations of the Duke of Devonshire's Commission, asking how far and how soon each school is prepared to carry these out, and tendering advice, should it be desired, on any details as to selection and sequence of subjects, teachers, text-books, outlay. Secondly, let them appeal to the Universities, to which many of them belong, as to the bearing of science scholarships and fellowships upon school teaching, and the extent to which such influence may be modified or ameliorated in that re-arrangement of College funds which next session will probably be commenced. Thirdly, let them be instructed to watch the action of Government in any proposal made either in pursuance of Lord Salisbury's bill, or as giving effect to the Duke of Devonshire's Commission, and let them be known to hold a brief for school science in reference to all such legislation. A single meeting of such a committee before the Association separates would settle a basis of action and compress itself into a working subcommittee. The time for papers and discussions is past; they have done their work. What the schools and the head-masters want is authoritative guidance; the guidance not only of a blue-book, but of a living leadership, central, commanding, and accessible, to which they may look with confidence, and bow without loss of prestige.

The precision of its dicta will clear up public confusion; its ability, conscientiousness, and popularity will overawe the clergy; schools and universities will listen respectfully to suggestions echoed by their own best men; and the three great departments of intellectual culture, equal in credit, appliances, and teaching power, will bring out all the faculties, and elicit the special aptitudes of every English boy.

"Hinc omne principium, huc refer exitum!"

HANBURY'S REMAINS

Science Papers; chiefly Pharmacological and Botanical. By Daniel Hanbury, F.R.S., &c. Edited, with Memoir, by Joseph Ince. (London: Macmillan and Co., 1876.)

A NOT inconsiderable contingent to the army of workers in science has been furnished by London trade. The ranks of our geologists, zoologists, and biologists, have been recruited to a larger extent than many might suppose from city counting-houses. But one would still hardly expect to find the same wholesale chemist's shop in an obscure court out of Lombard Street send forth, in two successive generations, two Fellows to the Royal Society. Except, however, in their common love of science, Daniel Hanbury was a very different man from William Allen, the druggist and Quaker preacher, the lecturer on chemistry and intercessor on behalf of the rights of conscience with almost all the "crowned heads" of Europe.[1] Retaining through life a warm attachment to the religious body in which he was born, Hanbury's religion was nevertheless of the closet rather than the forum; few of his friends ever heard him speak on religious subjects; and anything in the shape of proselytising was altogether alien to his mental constitution. Essentially a specialist, he was at the same time, what the best specialist must always be, an educated gentleman.

From the time when, as a very young man, he contributed his first essays to the *Transactions* of the Pharmaceutical Society, till his death at the early age of forty-nine, when a long career of usefulness seemed to be before him, the object to which Hanbury set himself was the clearing up of uncertain or disputed points regarding the botanical origin of drugs known to the pharmacopœias of this and other countries. Notwithstanding what he and fellow-workers on the Continent have done, it is surprising to find in how great obscurity the history is still involved of many medicinal substances which are daily prescribed by physicians and dispensed by druggists. The larger portion of the present volume is occupied with papers bearing on questions of this nature; those which will probably be found of the greatest value to posterity are:—"On the Different Kinds of Cardamom used in Commerce," "On Liquid and Solid Storax," "On the Source of Balsam of Peru," "Historical Notes on the *Radix galangæ* of Pharmacy," and "On the Determination of *Pareira brava*."

Hanbury's inquiries were characterised, above all things, by extreme thoroughness. No amount of research,

[1] Mr. Luke Howard, F.R.S., the eminent meteorologist, was also, for a short time, a partner with Allen.

o amount of personal labour, was spared to clear p or elucidate the smallest point bearing on the subject he was engaged in investigating. A good illustration of his mode of working is furnished by a paper read before a meeting of the British Pharmaceutical Congress held at Brighton, in 1872, "On Calabrian Manna." Manna is stated, in the "British Pharmacopœia" of 1867, to be "a concrete saccharine exudation from the stem of *Fraxinus Ornus*, L., and *F. rotundifolia*, D. C., which trees are cultivated for the purpose of yielding it chiefly in Calabria and Sicily." Never having heard of manna plantations in Calabria, nor seen Calabrian manna, Hanbury determined, after having acquainted himself with the literature of the subject, ancient and modern, to visit Italy himself in order to set the question at rest. At Florence he found the article almost unknown. Reaching Rossano, a town in Calabria Citra, he there found that the manna trees grow on some of the adjacent mountains, but are not cultivated; and that the collecting of the manna is a very small and insignificant branch of industry. "The habits of the Calabrian peasantry," he naively observes, "are such that it is impossible for travellers to quit the high roads without personal danger." At Corigliano, which, according to Murray's "Handbook," produces "the finest manna in Calabria," the industry is altogether extinct. At Cozensa, the capital of the province, anciently renowned for manna, he found the substance almost unknown to the druggists, one of whom assured him that its collection had been prohibited for the last six or seven years. Finally, a prominent English merchant at Messina was ignorant of the existence of such a commodity. The conclusion to which Mr. Hanbury came was that Calabrian manna has practically ceased to exist as an article of commerce, and that its collection in that part of Italy is on the verge of extinction. With regard, also, to De Candolle's species of manna-ash, *Fraxinus rotundifolia*, Hanbury's observations on the spot induced him to believe that while the *F. Ornus* is a very variable plant, there is no special form of it, and still less any distinct species, answering to the characters of *F. rotundifolia*.

By similar exhaustive investigations, Mr. Hanbury determined various other pharmacological questions of greater or less importance, of which two may be specially mentioned. In his paper on Storax, he shows that while the substance known under this name in ancient times was obtained from the *Styrax officinale*, L., it has altogether disappeared from the commerce of modern days, the resin now known as liquid storax being- notwithstanding erroneous assertions to the contrary in some writings of high authority—the product of a totally different tree, *Liquidambar orientale*, Mill., a native of the south-west of Asia Minor, where the drug is collected. The drug known in the British Pharmacopœia as "*Pareira brava*," was referred by most writers, without question, to the stem and root of *Cissampelos Pareira*, L., a climbing plant of the order Menispermaceæ, growing in the tropical regions of both the Old and New World. A scarcity of the article induced Mr. Hanbury, some years ago, to endeavour to obtain a supply from the West Indies. Having been furnished with the stems and roots of the plant in question, not only from Jamaica, but also from Trinidad, Ceylon, and Brazil, he soon discovered that the accepted statement was altogether erroneous. He then set himself to discover what "*Pareira brava*" really is; and a careful examination of the different descriptions by botanists and travellers, and of specimens obtained from various correspondents, led him to identify it with *Chondodendron tomentosum*, Ruiz et Pav., a native of Brazil, belonging to the same natural order. Mr. Hanbury was in the habit of preserving and carefully labelling, in his own museum, specimens of anything that could bear on the subjects of his inquiries; and his investigations were greatly assisted by unusual opportunities for growing foreign plants furnished by an extensive garden with abundance of glass, cold and heated, in one of the suburbs of London. Here was a true "botanic garden" to delight the heart of a pharmaceutist.

Mr. Hanbury's presence is sorely missed by his fellow-members of the various learned societies to which he belonged, especially of the two from the meetings of which he was seldom absent the Pharmaceutical and the Linnean; where his varied information was constantly giving life to the discussions, his urbanity of manner smoothing down any difference of opinion, and his business habits ready to assist at a critical moment. The last few months of his life saw the publication of his most substantial contribution to literature, the "Pharmacographia," brought out in joint authorship with his friend Prof. Flückiger, of Strasburg, to the importance of which these pages have already called attention.

DYNAMITE

Die Dynamite, ihre Eigenschaften und Gebrauchsweise. Von Isidor Trauzl. (Berlin: Verlag von Wiegandt, Hempel, und Parey, 1876.)

THE instructive brochure published under the above title affords an interesting illustration of the wide-spread applications now received by those violent explosive agents, nitroglycerine and gun-cotton, the practical value of which was regarded as doubtful even twelve years ago, by all but the few who devoted themselves indefatigably to the development of the manufacture, purification, and application of those substances. Capt. Isidor Trauzl has for some time past been intimately connected with the dynamite industry on the Continent, and is a very intelligent exponent of the properties and uses of the nitroglycerine preparations which owe their origin to the sagacity, ingenuity, and untiring labours of Alfred Nobel. The endeavours of Nobel to overcome the uncertainty and danger attending the application of nitroglycerine in its undiluted condition as an explosive agent, were eventually crowned with success by his elaboration of the plastic nitroglycerine preparations known as *dynamites*, of which the earliest, and that specially known as Nobel's dynamite, consists of the infusorial earth, *kieselguhr*, mixed with about three times its weight of nitroglycerine, which it holds absorbed, even under considerable variations of temperature, if the preparation be carefully manufactured. This material is the most violent nitroglycerine preparation now in use; it closely resembles Abel's compressed gun-cotton in explosive power as well as in regard to its action, and it is now very extensively used in all parts of the world, for mining, engineering, and other industrial purposes.

Capt. Trauzl's volume is specially and mainly devoted to the consideration of one particular class of operations to which dynamite, like gun-cotton, has recently been applied with considerable success, namely, to the removal of tree-stumps from forest-ground which is being cleared, as also to the felling of trees, the removal of piles, and similar operations. By the judicious application of these explosive agents, tree-stumps may be removed with much greater expedition than by manual labour, and the experimental results collected by the author, with special reference to this utilisation of dynamite, will be found valuable to large landowners or to those engaged in clearing land in new settlements. Many of the data given by him in regard to this application of dynamite, are confirmed by corresponding results obtained in this country in extensive experiments with both gun-cotton and dynamite.

The special information with regard to the removal of tree-stumps, &c., is prefaced by a concise account of the properties of dynamite and of the methods of preparing and exploding dynamite charges. Capt. Trauzl has done well to direct special attention to the necessity for care in handling dynamite, and especially in carrying out the essential operation of thawing frozen dynamite, the careless or ignorant performance of which has given rise to many frightful accidents. It has unfortunately been the practice with many whose interests are identified with the sale of explosive preparations of this class, to lay undue stress upon their great safety in transport and use, as compared with gunpowder, and thus to foster, to a very lamentable extent, the tendency to recklessness which is specially prevalent among the class of people who have to employ those explosive agents.

Capt. Trauzl concludes with a chapter on the application of dynamite to the breaking up of ground for agricultural purposes. It appears doubtful whether even the less violent forms of dynamite, the employment of which is suggested for this purpose (for which a comparatively gradual explosive effect is most advantageous) are likely to prove superior to gunpowder for this special application.

OUR BOOK SHELF

The Crimea and Transcaucasia; being the Narrative of a Journey in the Kouban, in Gouria, Georgia, Armenia, Ossety, Imeritia, Swannety, and Mingrelia, and in the Tauric Range. By Commander J. Buchan Telfer, R.N. Maps and Illustrations. Two Vols. (London: King and Co., 1876.)

THE author of this work took advantage of a three years' residence in Southern Russia to make acquaintance with the region to which his work refers, and which is pretty adequately indicated in the title. He does not, however, give a regular narrative of the visit he made to various places at various times, but arranges all the information he has collected along a route supposed to occupy ninety-two days. In this way a large tract of ground is gone over systematically, commencing at Sevastopol, visiting the surrounding district, coasting and touching at several places in the Crimea, crossing over to Circassia, coasting south to Poti, and penetrating through Mingrelia, Imeritia, and Georgia, south to Mount Ararat, and as far north as the country of the Ossety and the Swannety. Although no doubt many travellers pass through these countries, yet they have really been little explored, and in Commander Telfer's work will be found much information that, we are sure, will be new to the majority of readers. His account of the Swannety, especially, a curious mongrel, half savage people, to the north of Mingrelia, will be somewhat of a surprise to many. But the author has trusted not only to his own observations; he has taken evidently great pains to make himself master of all that is known of the history and antiquities of the region to which his work refers. This information he judiciously mixes up with his own observations, and the result is a work which may be regarded as a standard book of reference for the extremely interesting districts to which it refers. With its two good maps and its many illustrations, and its substantial and attractively put together information, it ought to take a prominent place among works of travel.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Basking Shark

IN NATURE, vol. xiv. p. 313, Prof. E. Perceval Wright gives some account of the Basking Shark, with especial reference to the curious pectinated appendages which lie along the branchial arches of that huge fish. His paper is illustrated by a characteristic woodcut from a drawing by Prof. Steenstrup, who had recently described these appendages, and who finds that they were alluded to by Bishop Gunnerus, about 100 years ago. Prof. Wright also gives a very interesting original figure of one of the branchial arches with the appendages attached.

Prof. Wright's notice will be welcomed as a further contribution to the history of a very remarkable and little-known structure. In one point, however, his description will need correction, for he speaks of the appendages in question as composed of a whalebone-like substance. They are nevertheless essentially different from whalebone, and were it not for their whalebone-like colour and for their pectinated arrangement, somewhat like that of the balene-plates of a whale, their comparison with whalebone would scarcely have suggested itself. Though elastic, they are hard and brittle, and when bent beyond a very limited angle, they snap like a plate of steel.

In consequence of the rarity of the opportunities afforded to anatomists for the examination of the Basking Shark, the pectinated appendages have hitherto received but little of the notice which is due to such a singular anatomical character, and the readers of Dr. Wright's communication might easily believe that since the days of Bishop Gunnerus no one but Prof. Steenstrup and himself had called attention to their existence.

It is now more than thirty years ago that in a communication to the Dublin Natural History Society I placed on record the capture of a Basking Shark on the south coast of Ireland and described the pectinated appendages as fully as the mutilated state of the specimen would allow. Since then I have in vain watched for an opportunity of further investigating the anatomy of the great shark.

The following is the abstract of this communication, published at the time in *Saunders's Newsletter*, which was then the vehicle for the proceedings of the Society. It contains perhaps little which has not been since noticed by Prof. Steenstrup and Prof. Wright, but I may nevertheless be permitted to quote it in order to show that the subject has not been so entirely ignored as the readers of Dr. Wright's paper might suppose:—

"A paper was read by Mr. Allman upon the recent occurrence on the Irish coast of the great Basking Shark, *Selachus maximus*, Cuv. This fish had been entangled in the trammels of the fishermen, and towed into the strand at Coolmain, on the southern coast of the county of Cork, when it was almost immediately cut in pieces by the country people with the expectation of obtaining oil from it. . . . The principal object of Mr. Allman's communication was to notice an interesting fact in the anatomy of this fish, which had not been hitherto described. The fact alluded to was the existence along each of the branchial arches of a very curious and beautiful pectinated structure consisting of a series of narrow elastic laminæ arranged with great

regularity, and constituting along each gill a kind of grating bearing a close resemblance to the teeth of a comb. The laminæ of which this grating is composed become gradually narrower from their fixed to their free extremities; they are of a dark olive colour, of a hard texture, and highly elastic, but at the same time brittle, and easily snapping off when urged beyond a certain point.

"The office which Mr. Allman assigned to these branchial appendages was that of strainers, by which the water before coming in contact with the branchiæ is freed from extraneous bodies, which would otherwise interfere with the functions of respiration. The objection which might be urged to this view, namely, that the other sharks are without any such arrangement appeared to him of no weight, as we know but little of the habits of the Basking Shark, and as those which we do know would lead us to believe that the structure just described is admirably adapted to the fish's peculiar mode of life. The Basking Shark must be entirely free from the voracious disposition so characteristic of the allied genera. Its teeth are little more than tubercles, and quite unfit it for the life of carnage led by other sharks. Its food must accordingly be found among the less resisting inhabitants of the ocean; and as the Basking Shark will therefore be driven to feed near the bottom and among seaweeds the existence of the branchial appendages will admit of an easy explanation. We must thus at once perceive the admirable adaptation of this interesting arrangement to the habits of an animal which would otherwise be subjected to the constant annoyance of having its branchiæ clogged with the floating fronds of sea-weeds, a circumstance which the anatomical structure alone would otherwise render more liable to occur in this than in the other sharks, as the openings to the branchiæ in the *Selachus maximus* are of enormous size, and the branchiostegous membranes particularly loose." GEO. J. ALLMAN

The Birds of Kerguelen Island

MY attention has been called to a review of Dr. Kidder's "Report on the Ornithology of Kerguelen Island," in NATURE of the 10th instant (p. 317, *supra*). Will you kindly permit me to express regret that the reviewer should have alluded to priority of publication of the results of the American and English expeditions to that island? To many persons his remarks on this point will appear to be ungenerous and needlessly sarcastic to the foreign naturalists. The subject is a delicate one, and I am sorry to have occasion to mention it, especially as an Englishman should be the last to approach it.

The reviewer will doubtless admit that when three naturalists are simultaneously sent to work independently of one another in the same neighbourhood, it is almost inevitable that one will anticipate the work of the others, and yet that there is nothing to boast of if he does. In the present instance, being bound to regard the interests of my employers in my collection, I hastened the issue of preliminary diagnoses of the novelties contained in it, to secure their types from alienation to foreign museums. The result of this was the acquisition by the English of the types of all the new species in my collection excepting those of one bird (which has recently been described as new by the Germans), and those of two Annelids, and three lichens, and perhaps a moss pre-occupied by the Americans. We could well have afforded to lose nine or ten times as many, and should still have retained a fair proportion of the whole number for English museums. The reviewer, therefore, might have done well if he had censured the rapacity of the English in grasping the lion's share of the type-specimens; but it was rather too bad of him to attribute to my fellow-workers small feelings of jealousy with reference to the Americans being the first in the field with their final reports, of which they are not conscious. The Americans have kept us fully informed as to the progress of their reports during the period of their preparation, by letter and by the transmission of advance sheets; and the English final reports will no doubt be ready at the time appointed by the Royal Society. If the Germans publish their results in the meanwhile, we shall have the advantage of including references to their work among our citations.

The reviewer is perhaps unaware of the publication of another Bulletin by the Americans, containing, amongst other information relating to Kerguelen Island, further ornithological particulars. It was issued more than a month ago.

A. E. EATON
Naturalist accompanying the English Transit of Venus Expedition to Kerguelen Island in 1874

Aug. 24

Antedated Books

I AM ready to give the Editor of the Zoological Society's *Transactions* credit for desiring to set a good and not a bad example; but, since a man seldom thinks that which he does to be wrong, the simple assertion of his opinion that it is the former and not the latter is not enough. Whether the papers in those *Transactions* are antedated by one month (as he admits) or by several months is merely a matter of detail. The practice of antedating is equally faulty in principle. If their editor would add the correct date of publication on the covers of the several parts, as is done with the *Proceedings* of the Royal and the *Journal* of the Linnean Society, he might give whatever date he pleases anywhere else as that of his latest revision.

ANOTHER F.Z.S.

Earthquake in Nithsdale, Scotland

ON the morning of the 12th current, at 3 o'clock, Mr. Robson, of the schoolhouse of Penpont, Dumfriesshire, was awakened by a sharp shock of earthquake and heard its detonations. On inquiry the same shock had been felt at the schoolhouse of Tynron, by Mr. Laurie; and over an area of several parishes around the upper course of the Nith the shock was felt, causing walls to vibrate and cupboard dishes to tingle. Two concussions of less violence were felt between 11 and 12 o'clock on the previous evening. The morning papers of the 14th report that a severe shock of earthquake had been felt at Athens on the morning of the 12th. It would be interesting to know the exact time when the shock was felt in Greece. On April 16th, 1873, at 9.55 P.M., a similar shock to that experienced last week was felt in the same districts of Nithsdale. I recollect communicating a short notice of it to NATURE at the time, as I had heard the strange sound, but on this occasion I did not hear it.

Tynron Schoolhouse, Aug. 23 JAMES SHAW

P.S.—Since writing the above I have received confirmation of the event from several other reliable witnesses. It seems to have been most plainly felt in the parishes of Morton, Penpont, Keir, Tynron, and Glencairn, to the west of the Nith. J. S.

The Cuckoo

THE usual manner in which the cuckoo in June "alters his tune," is by doubling his first syllable, and the "cuc-cuckoo, cuc-cuckoo" is then usually, if not always, followed by the single "cuc." This is certainly the case both near London and in the Midlands. E. H.

ABSTRACT REPORT TO "NATURE" ON EXPERIMENTATION ON ANIMALS FOR THE ADVANCE OF PRACTICAL MEDICINE[1]

VII.

THERE occur to me a few other illustrative series of researches, in which scientific and practical medicine have been advanced by experimentation on the lower animals. Some of these I will state in terms as brief as possible in the present paper.

Experimentation in respect to the Disease called Cataract.

Dr. Weir Mitchell, of Philadelphia, in the year 1869, made the original and remarkable observation that if a part of the body of a frog be immersed in simple syrup, there soon occurs in the crystalline lens of the eyeball an opaque appearance resembling the disease called cataract. He extended his observations to the effects of grape sugar, and obtained the same results. He found that he could induce the cataractic condition invariably by this experiment, or by injecting a solution of sugar with a fine needle, subcutaneously, into the dorsal sac of the frog. The discovery was one of singular importance in the history of medical science, and explained immediately a number of obscure phenomena. The co-existence of the two diseases, diabetes and cataract, in man, had been observed by France, Cohen, Hasner, Mackenzie, Duncan, von Graafe, and others, and von Graafe had stated that after examining a large number of diabetic patients in different hospitals, he had found one-fourth affected with cataract. Before Mitchell's observation there was not

[1] Continued from p. 341.

a suspicion as to the reason of this connection, and a flood of light, therefore, broke on the subject the moment he proclaimed the new physiological fact. Still more Mitchell showed that the cataract he was able to induce by experiment was curable also by experiment, a truth which will one day lead to the cure of cataract without operation. Then, but not till then, the splendid character of this original investigation, and the debt that is due to one of the most original, honest, laborious workers that ever in any age cultivated the science and art of medicine, will be duly recognised.

When the news of Mitchell's discovery reached us here, I took up the investigation at the point where he had left it. The fact he had announced was found to be indisputable. From a patient in one of our large hospitals, who was suffering from diabetes and double cataract, a specimen of the sugar excreted was obtained, and from that specimen the cataractous disease was induced in the frog, and afterwards removed. The experiment was conducted with the animal kept in an anæsthetic atmosphere, and was found to answer just as well as in the ordinary atmosphere; in fact, the experiment succeeded best with frogs when it was rendered free of all pain, as spasmodic movements, which may occur if the process of production of cataract is rapid, and which may suddenly kill, are prevented. Since the introduction of chloral hydrate, that anæsthetic has become a still more useful agent in this research, since its own action runs in line with the experiment, and the anæsthetic can be introduced in actual combination with the substance producing the cataract.

In warm-blooded animals I learned that the cataractous change could be brought about immediately after death. Several of the experiments were made therefore on the head of the sheep after the animal had been killed at the slaughter-house in the ordinary way, the fluid being injected through an artery. In other warm bloods the death was first induced by one of the anæsthetic vapours, and the fluid used was either injected into the peritoneal cavity or through the aorta.

The line of research which I carried on in continuation of Dr. Mitchell's discovery was for the purpose of determining the cause of the cataractous change and the influence of other agents in producing it. It occurred to me that the change was possibly due to the influence of saline matter on the pure colloidal lens, and if this were true the cataract ought to be induced by other substances than sugar. Any of the soluble crystalloids might produce it, and as there are many of these in the blood, there might be other cataracts than such as are produced by sugar in the diabetic subject. The research was therefore pursued with all the soluble salts belonging to the blood, and with the result of producing cataractous change with them all. In the end it was deduced that whenever the specific gravity of the blood is raised, by the presence of saline matter in it, to 10 degrees above the normal standard, and is sustained in that state for a short time, cataract is the result, and is maintained so long as the blood continues of the same specific weight. It was also found that the cataractous condition caused by the soluble blood salts was removable on the elimination of the added saline and the reduction of the blood to its natural equilibrium. At the same time there was observed to be a difference in the characters of the cataracts produced. Some of the saline cataracts were harder than the sugar cataracts and less easily curable. Those salts which are most fixed in their chemical constitution and at the same time are most soluble, produce the hardest cataracts. Those salts which are most easily decomposed, such as urea, are least effective in inducing the pathological change.

The change was found to commence, as a rule, in the posterior part of the lens, and after beginning as an imperfectly defined hazy spot it extended gradually through the whole structure, causing a pearly whiteness and complete opacity. In the process of cleaning of the lens the posterior part was the last to become transparent, but without exception the whole structure of the lens regained its crystalline clearness and its perfect function when the specific weight of the blood was reduced to its natural standard, if the circulation of fluid through the lens continued.

In these experiments two illustrious scholars, now lost to science, took the warmest interest, the late Professor Graham and the late Sir David Brewster. Both lent to me their valued observation. Graham saw in the experimental facts the first application in physiological pathology of his great discovery of the mutual action of colloidal and crystalloidal substances. Sir David drew some most ingenious inferences as to the physical cause of the opacity, tracing it to a process of crenation on the margins of the fibres of the lens. The greatest interest was naturally excited throughout the medical profession. In this production of cataract the first visible demonstration was offered of the synthesis of a well-known disease. It is now certain that if the specific gravity of the blood be raised rapidly a few degrees by a crystalloidal substance, cataract is the direct result. Recently Dr. Sansom saw this event in the case of a young woman suffering from diabetes, who became, in a few days, stone blind from cataract in both eyes; and, indeed, the cause of diabetic cataract is now made quite plain. But the end of the discovery is not reached with this fact, important though it be. The mode of production, in man and the lower animals, of the slowly advancing cataract, from which so many persons are rendered permanently blind, is after the same process, with a different saline, acting in a slower degree; and the inference is fair that some particular forms of diet are conducive to the disease. When the whole series of facts which Mitchell commenced to unfold are completed, the disease cataract will be understood in full. Its physical pathology is already understood, and if the operative art of the surgeon be not quenched by another mode of cure resulting from his discovery, it will be by the better art of prevention of the disease.

Experimentation on Pectous Changes.

The observations on cataract above described led me to follow out other lines of inquiry in respect to the action of saline substances on living and dead colloidal matter. I thus found that when a saline solution of a colloid, such as albumen, is brought into contact with a living colloidal structure like the peritoneum, the saline solvent is rapidly removed into the circulation, and the colloidal plastic substance is left on the true membrane as a false membrane, by which contiguous membranes are agglutinated together. I found further that if the blood or serous part of the blood in a fluid saline condition exudes into a serous cavity, the same simple physical process goes on, the saline and watery parts, including the colouring matter of the blood, passes back into the circulation through the membrane and the colloidal fibrine and albumen are left in form of false membrane or of band, on the true membrane. The experiment illustrates how inflammatory exudations, as they are called, are produced, and how adhesions and adhesive constrictions are formed after inflammatory serous diseases. The experiments on animals by which these results were arrived at, were all conducted under anæsthesia, and were perfectly painless.

In another analogous series of inquiries conducted in the same manner, I found that if the blood were surcharged with urea, a portion of albumen would pass out of the body by the urinary secretion without the institution of any marked morbid change in the structure of the kidney. This fact led me to ask whether albumen diluted with water and charged with urea would pass through a

dead membrane, by dialysis, and I found it would. These facts have bearings of the most singular kind on the disease albuminuria. They show, amongst other things, that the presence of albumen in the renal secretion is not, of necessity, a sign of structural disease of the kidney as has been supposed, and they account for the anomalous illustrations that are met with of temporary albuminuria as a disease. The experiments explain also the cause of that coagulation of the blood which occurs during those exhaustive diseases, such as cholera, in which the saline and watery parts of the blood are drained away.

The same line of research suggested to me a new experimental reading, conducted by experiment on dead animal matter, of the cause of the pectous change called, commonly, coagulation. This change I find is always produced in fluids containing soluble crystalloidal matter, colloidal matter, and water, whenever the relationship between the colloid and the water is disturbed by modification of the crystalloid. The crystalloid forms the connecting link by which the water is held in fluid combination with the colloid. If the crystalloid be withdrawn, then the molecular attraction of the colloid for its own parts commences, and the contraction called coagulation is set up with expulsion of water from the clot by the contraction of cohesion. If, on the other hand, crystalloid be added in excess, so as to absorb an excess of water, coagulation is also set up. Or again, if water held by condensation in a saline solution of a colloid—as the fibrine is held in the living blood for example—be allowed to escape, coagulation is the result.

Connected with these studies, but carried out long before them, are some experiments I made with urea, in which, by hypodermic injection of that animal salt, in free quantities, into the body of an animal, symptoms of unconsciousness and convulsion, like the symptoms of uræmic poisoning which occur in some cases of scarlet fever, were induced. The result to practice from these researches was to discover that the symptoms were removable by the abstraction of a little blood, and the application of this practice in examples of uræmia in man, has been the means of directly saving several lives. The result to physiological science was the fact that when from any circumstance the living blood is charged with a soluble saline body much beyond what is natural, the effect is a convulsion which recurs at intervals, as if the blood surcharged with the salt were conducting some exciting current to the muscles so rapidly that the reserve store of force in the nervous centres ran down or was completely discharged at once and had to wait to be re-supplied, at the end of each discharge, before another convulsion could be excited.

Dilution of the Blood and Feeding by the Veins.

In two great epidemics of cholera which I observed, it was impossible not to see that the cause of rapid death was, in most cases, the sudden reduction of the amount of water in the body. In some instances where all consciousness appeared to have passed away and death was declared, the recurrence of movements in the limbs of the apparently dead, suggested that in the strict sense of the word there was remaining life. In some instances the effect of injecting saline solutions into the veins had such an astounding temporary effect in bringing back the consciousness, it seemed as if we had in our hands a sure remedy, if we knew how to use it, for the worst forms of the fearful malady. The practice led me to experiment on the possibility of introducing water into the body by other channels than the veins, so that it might be gradually absorbed and might re-supply what was being lost by the watery discharges from the bowels. I therefore, in 1854, injected distilled water into the cellular tissue of anæsthetised animals subcutaneously, and also into the peritoneal cavity. The difficulty of introducing any sufficient quantity into the cellular tissue prevented that method from being followed; but with the peritoneum it was different. Into the peritoneal cavity I found not only that water, at the temperature of the body, can be introduced, through a hollow needle, without any danger whatever, but that the fluid is rapidly absorbed, and may be absorbed until as much as amounts to the fifth part of the weight of the animal is introduced into the organism. The difficulty I encountered in bringing into practice this simple means of re-supplying the body with water in cholera, lay in the fear that was expressed respecting injuries to the peritoneum. The plan was nevertheless once tried in a hopeless case in the human subject in 1854, and with perfect success in promoting recovery. At the present time, with our improved instruments for injection, and better knowledge of operations on the peritoneum, the method would be certainly applied in another outbreak of acute cholera, and I believe with most successful results. Beyond the directly practical, physiology gained a point by these researches. The experiments showed that when the blood is diluted by the addition of water, beyond a fifth of the weight of the animal, *i.e.*, by the addition of a pound of water to the blood of an animal weighing five pounds, an unconscious condition of the body is induced, with sleep, with paralysis of muscle, with reduction of temperature, and with death, if the natural balance be not quickly restored. Still further by pursuing the investigation into a comparison of the specific weight of the blood, and the specific weight of a fluid excretion such as the urine, I found that in some forms of serous dropsy attended with a very low specific weight of the fluid excretions, the blood when reduced in specific weight approaching to the specific weight of the secretions, is thrown out with the utmost ease into the serous cavities by the pressure of the circulation, is not returned by the osmotic ingoing current back into the circulating channels, and so accumulates in the serous sacs, giving rise to the phenomenon of serous dropsy.

Experimentation on the Action of Alcohol.

A very large number of my researches by experimentation have had reference to the action of medicines or of chemical substances intended to be applied as foods or as medicines to the animal body. Some of these, such as chloroform, methylene-bichloride, and nitrite of amyl, have already been noticed, but they are a small number compared with all that have been physiologically investigated. By subjecting animals of different species to the action of alcohol, I made clear what had only been surmised previously, that alcohol reduces the animal temperature. I also found that, like nitrite of amyl, alcohol produces what is called its stimulant action, by paralysing the vessels of the minute circulation. By the same course of experiment I learned that the exposure of an animal to a degree of cold that is perfectly harmless when the animal is free of alcohol, is certainly fatal when the animal is narcotised from the action of alcohol. By pursuing the research so as to include in it the heavier alcohols, such as butylic alcohol and amylic alcohol (fusel oil), I learned for the first time that the more injurious effects of some of the common alcoholic drinks sold for the uses of man are due to these exceedingly poisonous compounds; and by observing the action of alcohol, when the action is long-continued, on the visceral organs, the various organic changes it specifically engenders, independently of all other coincidental causes of disease, were accurately determined. In a word, all my researches of a physiological kind on the action of alcohol, from which so much has been gathered in respect to the utter uselessness and the great harmfulness of that potent poison, have been made from observation of its effects on the inferior animals. Its effects in reducing temperature, in reducing vascular tension, in reducing muscular power, in destroying the action of the animal membranes, in impairing the structures of vital organs, could

never have been certainly demonstrated if the lower animals had not formed the field of experimental investigation. In these experiments the lower animals suffered neither more nor less than millions of those human animals who indulge in alcohol, and I am sorry to say that, like the human animals, many of them became too fond of the agent that was producing their certain deterioration. I can but feel sure that a great number of facts of the most practical kind sprang from these researches on alcohol. To them also should be added one other addition to physiology. I traced out, in watching the effects of the heavier alcohol from the lighter of the series, the singular law that the physiological action of an organic chemical substance is intensified by the increase of its specific weight. Thus butylic alcohol is more pronounced in its action than methylic, chloroform than chloride of methyl, and so on through all the series of organic compounds.

Experimentation on Septine.

In 1864 the death from diphtheria of one whose life was dearer to me than my own, led me to study more carefully than I had before, the process of secondary absorption of secretions from diseased abraded surfaces. In the case in question I felt sure that the death was due to the absorption of poisonous secretion from the ulcerated throat and from the nasal passages. There was at that time no light to guide me to he truth except the experiments of Gaspard, Majendie, and Sedillot, which bore rather on the action of purulent matter and of decomposing blood upon the body, than on secretions formed during disease. I felt it right, therefore, to seek for further information by experiment, and this gave rise to the first steps of a research which has since assumed great importance. In the latter part of 1864 some fluid secretion had to be removed from the peritoneum of a patient suffering from surgical fever, on whom Mr. Spencer Wells had performed ovariotomy. The fluid, which was quite free from decomposition, was applied by inoculation to a healthy lower animal—a rabbit. It produced a special form of disease analogous to that from which the human patient was suffering. The secretions of the infected lower animal were tested in turn on another healthy animal, and were found to be equally and specifically poisonous. The same was extended through four series with like results. Some of the original fluid was next treated with the view of ascertaining if the poisonous principle in it could be isolated, and a series of salts were obtained which were found to possess a poisonous and progressive poisonous action like the original fluid. A poisonous organic base seemed, in fact, to be present in the peritoneal secretion, to which poison, whatever its nature might be, I gave the name of *septine*. I afterwards made a series of experiments to determine what agents destroy the activity of the poison, and from the whole of the inquiry, I was brought to a theory of the epidemic diseases which I have specially announced, and which will, I believe, hold its own, viz., that these diseases, are all glandular diseases, and that their poisons are specifically nothing more than the secretions of the glandular structures in a modified condition; that they may be produced with or without infection, and that they act in producing the acute symptoms of disease, after their absorption, by their effect, primarily, on the nervous system, and secondarily, on the blood. Recently, I have endeavoured to demonstrate that the fever which the septinous poisons produce is brought about by their power of liberating oxygen from the blood, and that those agents which counteract this action most effectively are the true febrifuges. As yet all such counteracting agents—one of which, quinine, is the best example—are clumsy and slow in their neutralising effect. But chemistry has agents much more potent, and the day, I am quite sure, is not far off when we shall have given to us neutralising agents for the contagious fevers which will be as refined and potent as the poisonous agents that produce the fevers, and which will cure fevers by inoculation from the lancet-point, as certainly as small-pox, or other infectious malady, is now producible by the process of inoculation of small-pox septine. By-and-by, and this will probably be the earliest step, we shall find a vapour, to inhale which will have the desired effect, and will be rapid in operation. This principle made perfect, there will be no such thing as a necessary death from an infectious disease.

At present, the view that the poisons of the spreading diseases are merely animal secretions, like the poisonous secretion of the cobra or the changed saliva of the dog under rabies (canine madness), removes all the mystery that surrounds them, and the various plans for preventing the distribution of the poisons and of infection is rendered common sense and simple to the extremest degree.

Experimentation on Painless Extinction of Animal Life

The latest experimental researches which I have conducted on lower living animals have had for their object the discovery of a ready, cheap, and innocuous method for killing without pain those animals which are destined, as yet, for the food of man. If the labour of the physiologist be allowed to progress, the day will soon arrive when the slaughter of animals for food will become unnecessary, since he will be able to so transmute the vegetable world as to produce the most perfect and delicious foods for all the purposes of life without calling upon the lower animal world to perform the intermediate chemical changes. But until this time arrives, animals will have to be slaughtered, and my research has been directed to make a process which at present is barbarous and painful, painless in the most perfect degree. For this purpose the various modes of rapid destruction of life—by powerful electrical discharges, by rapid division of the medulla oblongata, and by the inhalation of various narcotic vapours, have been carried out. The experiments, which have been exceedingly numerous, have led me to the conclusion that the most perfect of the painless methods of killing is by the inhalation of carbonic oxide gas. So rapid and complete is the action of this gas, that I may say physiological science has done her part, as far as it need be done, for making the painless killing of every animal a certain and ready accomplishment, an accomplishment also so simple that the animal going to its fate has merely to be passed through the lethal chamber, in order to be brought in senseless sleep into the hands of the slaughterer. The application of teaching and the putting into practice this humane process lies now with the world outside science; but to insure its acceptance, all the force of selfishness, of prejudice, and of practical apathy for the sufferings of the animal creation, have to be overcome. There is a great deal of talk and a great deal of sentiment abroad on the question of the sufferings of the lower animal kingdom, but when an attempt is made to relieve those sufferings by the invention of methods for operating, surgically without the infliction of pain, or for painless killing, the true and vital sympathy which one would expect in support of such practical and humane efforts, until they are made perfect and universal, can scarcely be said to be found at all. With the exception of a few, not a dozen altogether, of really humane ladies and gentlemen, I have found no one, out of the ranks of science, in the least interested in the saving of sufferings to which I am now directing attention. The man of science stands and wonders at the strangeness of the psychological problem before him; and, in spite of himself, is forced to the conclusion that, practically, the noise that is made at him in the name of humanity is, after all, sounding brass and tinkling cymbal.

BENJAMIN W. RICHARDSON

STANLEY'S AFRICAN DISCOVERIES

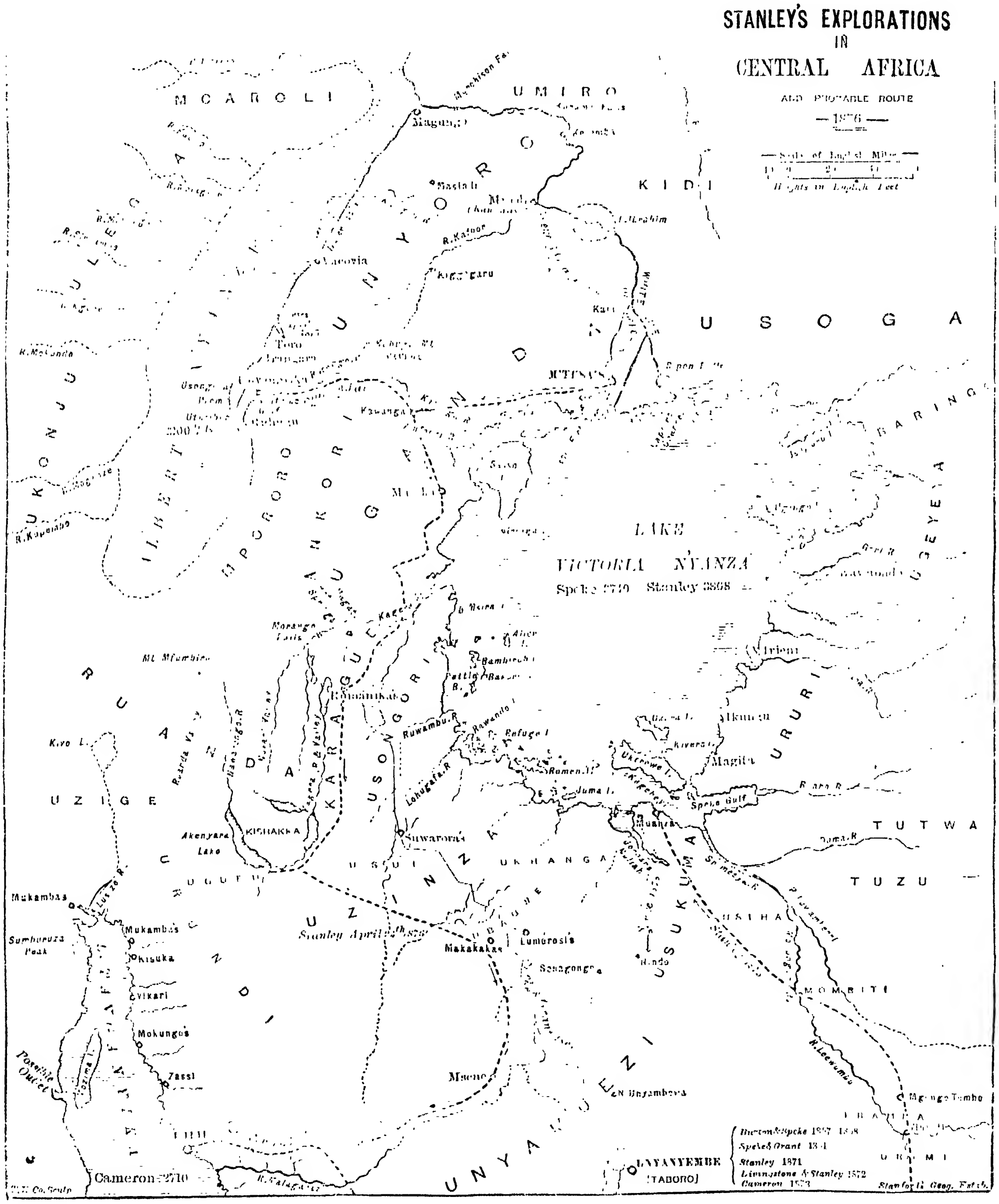
MR. STANLEY, in the work he has already done, has made a substantial contribution to African geography, and the last letters from him which have recently appeared in the *Daily Telegraph* raise eager hopes that shortly we shall hear of his having accomplished work of even greater value. We do not propose to recapitulate the narrative with which most of our readers must be familiar from the interesting letters in the *Telegraph*, bu briefly to point out, with the aid of the accompanying map, how much Mr. Stanley has in these letters added to our knowledge. Of course our map does not pretend to rigid accuracy, its object being simply to show Mr. Stanley's route, the amended outline of the Victoria Nyanza, and the main features of the country traversed by him. It is not our desire to take up space with conjectural geography, nor to reconcile Mr. Stanley's statements with those of previous travellers, nor to discuss what is likely to be the tendency of future discoveries. All this seems to us unnecessary at present, as there is every probability that we shall not have long to wait for accurate and full information from the various travellers that are now in the field.

One of the most satisfactory parts of Mr. Stanley's work is undoubtedly his circumnavigation of the Victoria Nyanza, and the filling in of its outline with something approaching to accuracy. Previous to Mr. Stanley's visit we were dependent mainly on conjecture for the configuration and dimensions of this important lake, supplemented by the observations at one or two points of Speke, on whose name Mr. Stanley's discoveries have shed additional glory. Anyone comparing the map which we have drawn up from Stanley's information with that of Speke will be able to see how much the latest traveller has done. The outline of the shore all round is given with what we must regard as a fair approach to accuracy, to be supplemented ere long, we hope, by careful survey. The long branch lake on the north-east has been cut off, probably to become a separate lake or marsh further east; the eastern shore has been brought considerably westwards, while the southern and western shores have received important modifications. The "numerous islands" of Speke's map have many of them been visited and most of them been seen and named, and are found to extend almost all round the lake at a short distance from the shore. The names at least of many of the tribes that inhabit the shores and the islands have been obtained, and not a few details concerning their customs and physique. Stanley's account of his visits to Mtesa are in the highest degree interesting, and cannot but raise our admiration of the excellent diplomacy of the determined commissioner of the *Telegraph* and the *Herald*. As to the extent of the lake, the conjecture that it is about 1,000 miles in circumference is probably not far from the mark; from the observations of Stanley its height above sea level is calculated to be 3,800 feet, very near to one, at least, of the observations obtained by Speke.

Probably after the circumnavigation of the Victoria Nyanza, the most satisfactory piece of work done by Stanley has been the tracing of a large portion of the lacustrine river Kagera, the same which Speke had under an apparent misconception named the Kitangule. Stanley during his circumnavigation ascended the mouth of the river and found it to enter the lake about twenty miles further north than was conjectured by Speke. What is, however, of more importance, is the careful exploration of this curious river further up its course, confirming and extending the discoveries previously made by the careful Speke. Speke's Lake Windermere has been found to be only one of a series of at least seventeen lakes, which are in reality one, which are fed and drained by the river Kagera, and which Stanley with considerable reason regards as "the real parent of the Victoria Nile," and along with the Shimeeyu River on the south, the main feeder of the Victoria Nyanza. Stanley's account of his exploration of this lake-river is of such importance that we shall quote his own words:—

"While exploring the Victoria Lake I ascended a few miles up the Kagera, and was then struck with its great volume and depth—so much so as to rank it as the principal affluent of the Victoria Lake. In coming south, and crossing it at Kitangule, I sounded it and found fourteen fathoms of water, or 84 feet deep, and 120 yards wide. This fact, added to the determined opinion of the natives that the Kagera was an arm of the Albert Nyanza, caused me to think the river worth exploring. I knew, as all do who understand anything of African geography, that the Kagera could not be an effluent of Lake Albert, but their repeated statements to that effect caused me to suspect that such a great body of water could not be created by the drainage of Ruanda and Karagwe, and that it ought to have its source much further, or from some lake situate between Lakes Albert and Tanganyika. When I explored Lake Windermere I discovered, by sounding, that it had an average depth of 40 feet, and that it was fed and drained by the Kagera. On entering the Kagera, I stated that it flashed on my mind that it was the real parent of the Victoria Nile; by sounding I found 52 feet of water in a river 50 yards wide. I proceeded on my voyage three days up the river, and came to another lake about nine miles long and a mile in width, situate on the right hand of the stream. At the southern end of this lake, and after working our way through two miles of papyrus, we came to the island of Unyanyubi, a mile and a half in length. Ascending the highest point on the island, the secret of the Ingezi or Kagera was revealed. Standing in the middle of the island I perceived it was about three miles from the coast of Karagwe, and three miles from the coast of Kishakka west, so that the width of the Ingezi at this point was about six miles, and north it stretched away broader, till beyond the horizon green papyri mixed with broad grey gleams of water. I discovered, after further exploration, that the expanses of papyri floated over a depth of from 9 to 14 feet of water, that this vegetation, in fact, covered a large portion of a long shallow lake; that the river, though apparently a mere swift-flowing body of water, confined seemingly within proper banks by dense tall fields of papyri, was a current only, and that underneath the papyri it supplied a lake varying from five to fourteen miles in width, and about eighty geographical miles in length. Descending the Kagera again some five miles from Unyanyubi, the boat entered a large lake on the left side, which, when explored, proved to be thirteen geographical miles in length by eight in breadth. From its extreme western side to the mainland of Karagwe east was fourteen miles, eight of which was clear open water; the other six were covered by floating fields of papyri, large masses or islands of which drift to and fro daily. By following this lake to its southern extremity I penetrated between Ruanda and Kishakka. I attempted to land in Ruanda, but was driven back to the boat by war-cries, which the natives sounded shrill and loud. Throughout the entire length (eighty miles) the Kagera maintains almost the same volume and nearly the same width, discharging its surplus waters to the right and to the left as it flows on, feeding, by means of the underground channels, what might be called by an observer on land seventeen separate lakes, but which are in reality one, connected together underneath the fields of papyri, and by lagoon-like channels meandering tortuously through between detached fields of this most prolific reed. The open expanses of water are called by the natives so many "rwerus," or lakes; the lagoons connecting them and the reed-covered water are known by the name of "Ingezi." What Speke has styled Lake Windermere is one of these "rwerus," and is nine miles

in extreme length and from one to three miles in width. By boiling point I ascertained it to be at an altitude of 3,760 feet[1] above the ocean, and about 320 feet above Lake Victoria. The extreme north point of this singular lake is north by east from Uhimba, its extreme southern point. Karagwe occupies the whole of its eastern side. South-west it is bounded by Kishakka, west by Muvari, in Ruanda, north-west by Mpororo, north-east by Ankori.



At the point where Ankori faces Karagwe the lake contracts, becomes a tumultuous noisy river, creates whirlpools, and dashes itself madly into foam and spray against opposing rocks, till it finally rolls over a wall of rock ten or twelve feet deep with a tremendous uproar—on which account the natives call it Morongo, or the Noisy Falls."

[1] There is evidently an inconsistency between this statement and the height (3,800 feet) above given for the Victoria Lake. The latter, however, is Capt. George's computation from Stanley's readings. Stanley's observations will no doubt be revised when his readings for Lake Windermere are sent home. Meantime we must let his statement stand.

Mr. Stanley does not exaggerate the importance of this discovery. That the river has any connection with Tanganyika is in the highest degree improbable, as the Victoria into which it drains is more than 500 feet above the level of Tanganyika; but the question of the connections of this lake Mr. Stanley, we hope, has by this time solved. He afterwards traced the Kagera upwards in a south and west direction, the direction in which trend all the ranges in this region, as, indeed, run all the great ridges, troughs, basins, and valleys from Alexandria to the Nyassa Lakes. In Southern Kishakka, however, a valley struck in from the north-west, through which he found issuing into the Kagera, a large lake-like river called Akanyaru. Above the confluence the Kagera was seen to be a swift-flowing stream of no great depth or breadth. From the Mlagata hot springs Stanley obtained a good view of the region to the north-west, including the Ufumbiro mountains, two sugar-loaf cones and a ridge-like mass, reaching a height of 12,000 feet. From this point of view, also, he saw three other lofty ridges separated by broad valleys. Between two of these ridges flows the Nawarongo river rising in the Ufumbiro mountains, and flowing south by west to join the Akanyaru lake-river. Another large lake he heard of as lying to the westwards, but of this he could obtain no certain information.

Of Stanley's visit to Lake Albert Nyanza little need at present be said, as he succeeded in obtaining only a glimpse of it, when he felt himself compelled to return. Some important observations, however, he did succeed in making, and collected many scraps of information. His statements about "the king of mountains," Gambaragara, and its pale-faced, brown-haired inhabitants, the chief medicine-men of the notorious Kabba Rega, have roused curiosity to the utmost. This mountain, which appears to be situated somewhere on the north of Unyampaka, in height between 13,000 and 15,000 feet. Mr. Stanley conjectures to be an extinct volcano, as "on the top of it is a crystal-clear lake, about 500 yards in length, from the centre of which rises a column like rock to a great height. A rim of stone like a wall surrounds the summit, within which are several villages, where the principal medicine-man and his people reside." Stanley's route to the Albert Lake was partly through Unyoro and partly through an uninhabited tract of Ankori, his camp being pitched near the edge of the plateau which borders the lake, in the district of Unyampaka. During his march he made important observations on the contour of the plateau which separates the two lakes, the structure of the mountains and ridges, the course of the watersheds and of the rivers Katonga and Rusango. The general correctness of Baker's map, so far as the east coast is concerned, has been confirmed, and although the actual lake may not extend south of the equator, it is probable that there are long stretches of papyrus swamps at its head. The kingdom of Unyoro, under Kabba Rega, occupies a large extent of the eastern shore of the lake, and includes many minor states, the names of which, and of others on the west side, Mr. Stanley succeeded in collecting. The extensive promontory of Usongora, forming Beatrice Gulf, on the shores of which Mr. Stanley encamped, is the great salt-field whence all the surrounding countries obtain their salt, and rumour makes it a land of wonders, with a mountain emitting fire and stones, a salt lake of great extent, hills of salt, and a breed of large savage dogs and long-legged natives. Mr. Stanley gives the latitude of his camp on Lake Albert as 0° 25′ N. and longitude 31° 24′ 30″ E. It is difficult to reconcile this last datum with previous observations, and indeed with the length of Stanley's own march between the two lakes. If his own map of Victoria is correct, the two lakes must be within thirty miles of each other. It is probable, we believe, that Sir Samuel Baker's map places the east coast of the lake too far west, and that its position will have ultimately to be changed, but if to so great an extent as is indicated by Stanley's statement, must be solved by further observations. At present we cannot reconcile Signor Gessi's narrative with that of Stanley. Gessi states that he was stopped in his navigation by a "forest of Ambatch," some thirty miles to the north of Stanley's Beatrice Gulf, and that the natives declared the lake extended no farther south. The statements of the two travellers are equally positive, and we have no reason to distrust either, and therefore we can only wait for more information, which, it is likely, will now soon reach us, either from Mr. Stanley or Mr. Lucas, an independent traveller, who is actuated purely by a love of exploration, and who, by last accounts, was on his way to the lake.

On his return from this expedition Mr. Stanley set out southwards through Karagwe for Ujiji, his purpose being, if possible, to reach Lake Albert from the west and make as thorough an exploration of it as he has done of the Victoria Lake. The chances are that he will be successful. It was while in Karagwe that, by the assistance of the hospitable old king Rumanika, he was able to explore the Kagera lacustrine region. On completing this exploration he visited the hot springs of Mlagata, two days' march from Rumanika's capital, in a deep-wooded gorge clothed in the most luxuriant vegetation. These springs reach a temperature of about 130° Fahr., and are greatly resorted to for their supposed curative effects, which Mr. Stanley seems to doubt.

Mr. Stanley's last letter is dated April 24, 1876, from Ubagwe, Western Unyamwezi, fifteen days' journey from Ujiji, which, if all has gone well, he will have reached long ago. Before setting out for Lake Albert again, he proposed to explore the hitherto unvisited portion of the north-west shore of Tanganyika. From this exploration some authorities expect important results to follow; it is indeed thought possible that in this direction will be found the real outlet of Tanganyika, and that Cameron's river Lukuga may ultimately be discovered to be after all only an indentation of the lake, and that moreover a connection will be found between Tanganyika and the Albert Nyanza. However this may be, both explorers have done work of the highest importance in African geography, and the last published letters of Stanley must be regarded as a really valuable contribution to the solution of the great Nile problem and to an accurate knowledge of Central Africa. He has proved himself an explorer of the greatest capability, and the expedition he leads reflects credit on the enterprise and public spirit of the proprietors of the two newspapers who have sent him out.

COFFEE IN CEYLON

CEYLON is perhaps best known to Europeans through being one of the chief coffee-growing countries in the world, and indeed, after its production of cinnamon, which gives it a position that is quite unique, its chief claims to notice from the ordinary untravelled Englishman are derived from its coffee. The plant is supposed to have been introduced into the island by Arabs from the Persian Gulf more than 200 years ago, as there are traditions extant among the Singhalese of its flowers having been offered at the shrine of the sacred tooth of Buddha in Kandy at a remote date. The art, however, of preparing any beverage from its berries was unknown to the natives, or at least unpractised by them until recent times, and it was only in 1827 that the first plantation was opened—by Sir Edward Barnes, the then Governor—with the idea of exporting coffee to the European market. This estate was situated not far from Kandy, and at an elevation of some 1,800 feet above the sea. Thirteen years afterwards the first rush of speculators in coffee occurred, when the average quantity exported was 54,000

cwts., and its value about 150,000*l*. The effect of this sudden impulse to the enterprise was seen six years afterwards, in 1846, in the export rising to 178,000 cwts. In 1855 it was close upon half-a-million, and in 1868 somewhat over a million cwts., valued at the low rate of about 50*s*. per cwt., and grown on an area, including native coffee gardens, of about 200,000 acres. In the following year "leaf disease" (*Hemileia vastatrix*), a species of fungus covering the under surface of the coffee-leaf with an orange-red coloured dust composed of the ripe spores of the fungus, appeared on a newly-opened estate in Madulsima, and within a very short time spread over all the coffee-producing districts in the island. The ravages of the pest have been so great that the annual production of coffee has been reduced to less than two-thirds of what it ought to have been, and the loss to the colony can only be estimated at many millions of pounds sterling. But this subject will be referred to later; at present we must attempt to give some idea of the character of the country in which the great staple of the island grows. Ceylon, as is pretty generally known, consists, roughly speaking, of a large central mass of mountains, attaining an elevation in one case of more than 8,000 feet, and surrounded on all sides by low country. This mountain region, as well as the low country, is composed almost entirely of primary rock (gneiss), and bears such a striking resemblance to the Western Ghaut Range of Southern India, that the island may be considered as an isolated portion of that continent, separated, perhaps, during the upheaval of both by the strong monsoon currents that set continually along the coasts of India, according as the sun is north or south of the line. It is not improbable that other stratified rocks have once overlaid the ancient gneiss, but no rock less tough could long withstand the torrential rains of the south-west monsoon and the injurious effects of a tropical sun. If any such have formerly existed, every trace of them has long ago been washed down to the low country or the sea. It is true that at one spot on the western coast, apparently protected from the violence of the monsoon rains, and where, consequently, the rainfall is very slight, the remnant of a fossiliferous limestone of very limited extent is to be met with, but this, I believe, is the one solitary exception, and its relation to the gneiss formation of the rest of the island and to the coast of Southern India, has not, I imagine, been sufficiently explained. At the present time the soil of Ceylon is formed exclusively by the disintegration of gneiss rock, the *débris* of which settles in protected spots and on slopes not too steep for its accumulation. In its natural state it is nearly always very strongly tinged with red, and to an ordinary observer appears to be of a very poor character. This no doubt is really the case, but it affords standing-ground for trees and other forms of vegetable life, and a forcing climate does the rest. With a rainfall over the greater part of the mountain zone of more than 100 inches, in some places more than 200 inches in the year, distributed chiefly between the middle of May and the end of December and with such a rapid descent from the upper mountain slopes to the low country—the great river of the island, the Mahawelliganga, descends at the average rate of ninety feet per mile for the first sixty or seventy miles of its course—it was only to be expected that extremely deep valleys, steep slopes and precipices, and a general waterworn aspect should be met with on every side. These features are so marked throughout the coffee-producing districts, that it is by no means unusual to find the upper portion of a block of 300 acres some 1,800 or 2,000 feet above the lower, and the whole estate nothing more than a series of rounded spurs and deep ravines, with here and there a precipice of considerable height, with an accumulation of rocks about its base. It is at the foot of these cliffs that the best soil for any purpose of cultivation is found, whilst the worst is generally on the most exposed parts of the spurs. This is no doubt due to the accumulation of vegetable mould, and the nutritive properties of the decaying rocks, which is possible in the one case, but not in the other, to any great extent. It is to the former of these substances, to the result of ages of forest growth and decay, that coffee estates owe their chief value; without it they are almost worthless, as may be seen in the case of old estates, whose surface-soil has been washed away through want of drainage or on the grassy slopes of *patanas*, where jungle has never grown, and where of course there is no humus. On either it is next to impossible to grow coffee profitably. As these patanas or patches of poor grass land in the midst of luxuriant forest form one of the most striking features of the mountain scenery of Ceylon, and as no satisfactory explanation has as yet been given of them, it may be well to mention that a band of quartzite (metamorphosed sandstone) several hundred feet in thickness, occupies a definite place in the gneiss series of the mountain zone, and that wherever this is found cropping out, and by its disintegration forming the surface-soil, there we are certain to find the ground of such miserable quality that nothing but a coarse and all but worthless grass will grow. This, however, does not fully explain the phenomenon. It may be noticed as against the theory that these patanas are due to the frequent burnings by the natives after the land has once been cleared of jungle, and then allowed to fall into grass, that, however land that has once been jungle may be exhausted by bad cultivation, its tendency is not to run into grass, but to relapse into a kind of scrub, and thence in time into jungle—a tendency which is never seen in patana land. The best estates, the climates being similar, are where the humus is deepest, or where its constituents have been carried furthest by percolation into a friable soil. The protection of this humus and upper soil is the first and most important duty of the planter on a new estate, and the drainage, therefore, at the outset, is rendered as complete as possible.

An idea of the rate at which the surface soil even of old and well-worn estates is carried away, may be formed from the fact that $\frac{1}{60}$th part by weight of the surface-water passing down a stream in Pussellawa—one of the oldest and best coffee districts—after a heavy shower was found by the writer to be earthy matter; a startling observation indeed, but one that fairly agrees with an estimate made, after considerable experience, that one of the above-mentioned old estates had suffered denudation since it was opened more than thirty years ago, at the rate of about one-third of an inch per annum. This is a startling fact and suggests the inquiry, When will the land available for coffee in Ceylon be used out or washed away? It is already nearly all occupied, and it seems that before long, that is, within a score or two of years, in spite of all the exertions of the modern planter, all its fertile properties will be irrecoverably lost. Forest growth and decay have created the wealth of the Kandyan Province, and the ignorant or careless planter of the past has as truly wasted the natural resources of the country as if he had destroyed all its coco-nut trees, only in the one case the evil would be temporary—twenty years would repair it; in the other ten times that period of absolute rest would probably not restore the fertility to the mountain slopes and bring them again to the state in which the European found them. Land suitable for coffee lies generally between 2,000 and 5,000 feet above the sea, but the climate of the district and the aspect count for a good deal. Estates from 3,000 to 4,000 feet in altitude are considered the best, the plants then being neither burnt up by the hot sun of lower elevations nor ruined by the black-bug—really a fungus, *Capnodium*, thriving on the honey-dew secretion of the bug *Lecanium Coffeæ*, and often mistaken for it—which is a sure visitor of high and wet estates. An eastern slope is generally preferred, but what effect the early sun produces I have never been able to

discover—unless it saves the plant to a great degree from the chills of early morning.

As to climate the variety in this respect is most marked. On one side of a small range the coffee exposed to the south-west monsoon is mostly ripe about November. On the opposite side, four miles away, where it is subject to the influence of the north-east rains, it is generally picked three if not four months later, whilst in the most favoured districts in the southern part of the mountain zone where the rainfall is considerably influenced by mountains that lie in the track of the monsoon the crop time lasts through nine months, *i.e.*, from September to May—buds, flowers, green and ripe fruit, being on the tree all at the same time.

Young plants are generally put into the ground soon after the rainy season has commenced, stumps being used in the southern part of the province and where the weather is uncertain. Under the influence of a plentiful supply of moisture and an average temperature of 70° to 75° F., the roots soon strike and the tree grows so rapidly, that at the end of two years a small quantity of fruit may sometimes be gathered. In its fourth year the tree bears a good crop, and two years later it may be considered to be in its prime. About 1,200 to 1,600 are generally planted on an acre, and each tree, when it attains a height of four or five feet, is cut down to 3 ft. 6 ins., and even lower in exposed places and on poor soil, according to the taste of the planter. The lateral branches are kept most carefully pruned, and the tree thus cared for forms a cylindrical mass of foliage into the centre of which the sun's heat can penetrate and ripen the fruit. The trees are planted six feet by five feet or six feet apart, and when fully grown in good soil, present a mass of intervening branches through which it is somewhat difficult to make one's way. When an estate has attained an age of twenty years it is considered to be well past its prime, and only to be kept profitable by means of a plentiful supply of manure, and indeed the main question with planters now is not so much how to treat the tree itself, but how to obtain good fertilising material and apply it in the best manner possible. The tree responds to kindly treatment with the utmost readiness, and will bear almost any ill-usage and yet recover and yield good crops. Ten cwts. to the acre, or nearly one pound per tree of prepared coffee, used formerly to be considered a good crop, but now, owing to the ravages of the "leaf disease," it is regarded as extraordinary, and half the amount only is more frequently obtained. At present prices this represents about 25*l.* per acre with which to pay all the working expenses of the estate. Amongst these is the cost of Tamil coolies from the south of India, who have to be maintained during the greater part of the year at the rate of one labourer to every acre of coffee in full bearing, their pay averaging 9*d.* per day of ten hours, viz., from 6 A.M. to 4 P.M. Besides this main charge there are artificial manures, tools, bullock-waggons, bullocks specially kept for making manure, road-making, &c., to be paid for, together with assessments for grant-in-aid roads, and other public purposes, so that to manage an estate well is a very expensive affair, and can only be done where there is a large incoming of gross profits.

No mention has yet been made as to how the land is acquired by the planter and under what title it is held. When the English took possession of the Kandyan province in 1815, they agreed, by a convention, to respect both the religion and the private property of the natives. This latter consisted chiefly of rice-fields, whilst the jungle-covered mountains having never been considered of any value were not claimed, and consequently passed into the hands of the British Government. As soon, then, as their value began to be appreciated for coffee cultivation, they were put up for public sale at an upset price of 5*s.* per acre, and many estates were purchased at that rate. At the present time the upset price is 1*l.*, and the land not unfrequently realises as much as 15*l.* or 20*l.* per acre, so prosperous has been the enterprise of late years and so great the influx of English capital. The blocks of land when put up for sale are mostly of convenient sizes—200 or 300 acres—and the competition is frequently very keen for the more suitable pieces. As none but jungle land, except in very rare instances, is planted with coffee, the forest and undergrowth have to be cleared away and the ground thoroughly opened before the plants can be put in. This is done in November or December by Kandyan woodmen, who are very skilful with the axe, and the remains of the forest having been dried by an eight or ten week's exposure to the sun during the hot season are burnt off about February. As soon as the rainy season comes, holes 18 inches square and deep are dug, and the plants, having had their rootlets carefully trimmed, are deposited in them. At this period of its formation the estate is generally quite free from weeds on account of the recent fire, and very great care is used to prevent any, especially ageratum or couch grass, getting a hold on the soil.

As to the general statistics of the enterprise I find by Mr. Ferguson's very valuable directory that there are at the present moment 257,000 acres of cultivated coffee, divided into slightly more than 1,200 estates, and giving employment to 1,050 managers and superintendents, nearly all of whom are Europeans. Some 50,000 acres of these estates are not in proper bearing, through being either too young or too old, and therefore 210,000 acres may be taken as the extent of the plantations of the island, which are accountable for the present year's crop (ending in September), estimated at 630,000 cwts. Last year the yield, with 8,000 acres less in cultivation, was 873,000 cwts.

The value of the whole plantation interest is roughly estimated at nine millions sterling of English money.

The extent of native coffee, *i.e.*, of the gardens of the Singhalese, which are generally situated in the immediate neighbourhood of their villages, where the trees are allowed to grow as they will, is probably between 40,000 and 50,000 acres, and the average annual production may be estimated at from 140,000 to 150,000 cwts. The value of this native property is set down roughly at three-quarters of a million sterling.

In 1849 the value of the former variety of coffee when prepared was 33*s.*, and of the latter 18*s.* per cwt. At the present moment so great has been the rise in the prices of both kinds that plantation fetches as much as 100*s.* and native 85*s.* per cwt.

A comparison of the statistics of the coffee enterprise for the year 1852 (the earliest for which I have any reliable information) and the present year furnishes several points of interest both to the planter and the European consumer. The former was a fairly good year, better than 1853, but not to compare with any of the immediately succeeding years. The latter year is distinctly a bad year, but whether exceptionally so or not is the chief point of interest and anxiety. In 1852 about 40,000 acres were under plantation cultivation, and 255,000 cwts. were produced, nearly 6½ cwts. per acre. In the present year about 257,000 acres are cultivated—one-fifth perhaps not being in full bearing, as was probably the case in 1852—and 630,000 cwts. are expected to be obtained, an average of less than 2½ cwts. per acre. The native coffee produced in the same two years will most probably be about the same in quantity, viz., 150,000 cwts. A fairer mode of comparison, no doubt, is that of taking the last five years, say from 1872 to 1876 inclusive, and comparing the average annual production per cultivated acre during that period with that of the five preceding years from 1867 to 1871, for it was in 1872 that the falling-off due to the "leaf disease" began to be seriously felt. During the earlier five years the rate of production per acre was 4·6 cwts. During the later period only 2·9 cwts., a decrease of somewhat more than one-third. It may

naturally be asked, What is the cause of this falling-off in the average production? One reason, no doubt, is that some estates are becoming old, and when an unfavourable season occurs their cultivation is temporarily unprofitable. But the main cause is most certainly the fungus (*Hemileia vastatrix*) on the leaves of the plant. This appeared first in 1869, and in 1872 was recognised as a firmly-established coffee pest. It is generally admitted that the injury is caused through the weakening of the tree by the absorption of the juices of the leaf, for no plant has ever been known to be absolutely killed by the attack or even by a succession of them. The first symptom of the disease is a palish discoloration in spots or patches, easily detected when the leaf is held up to the light. These quickly assume a faint yellow colour, and presently become covered with yellow dust, which soon turns into a rich orange. These are the ripened spores of the fungus aggregated in little clusters, and attached to branching filaments, that have found their way from the air-spaces within the leaf, where they have been feeding on its juices and ruining its vitality. It is estimated that there are sufficient of these spores on a badly diseased leaf to infect 100,000 plants, and therefore it is no wonder that the pest, when once it had come to maturity under the favourable conditions of a coffee estate, should spread in an incredibly short space of time over the whole mountain zone, and that probably within less than two years from its first appearance every coffee-tree in the island had been more or less affected by it. The injury in the first instance appears to be done solely to the leaf, which, at a certain stage of the attack, dies of exhaustion, and the tree being an evergreen has to throw out another mass of foliage, which also in its turn becomes affected and dies. Consequently the strength of the plant, which ought to be spent in bearing fruit, is chiefly devoted to putting out new flushes of leaves, whilst a certain percentage of the crop that is at last ripened is found to have suffered from the general weakness of the tree. For a disease of this kind it is impossible to suggest any remedy, such as sulphuring the leaves. Imagine such an operation as sulphuring more than 250,000,000 trees, and then only obtaining a temporary relief! Manure gives a tree strength to bear fruit as well as leaves, and therefore is the most approved of all the remedies tried as yet.

With regard to the origin of the disease, nothing is known, except that it first appeared on a new estate in Madulsima, a district in the south-east of the mountain zone, and bordering on the low country. Mr. Thwaites, the botanist, believes that it has been introduced into the island in imported manure, which is a probable explanation of its origin, so far as Ceylon is concerned. Against this supposition, however, is to be set the fact, according to the writer's belief, that *Hemileia vastatrix* is found in no other country in the world except Southern India, and on no other tree except the coffee-tree. It is, therefore, possible that it may have existed in a modified form, and without attaining any great development on some of the trees in the low country jungle to the eastward, and from them may have been carried by the wind to a neighbouring coffee estate. Be this as it may, it is not now likely that its origin will ever be known, unless future research into the nature of fungi throws a light on the subject which it is impossible to anticipate. As to the future of the coffee enterprise in Ceylon, it is useless to predict. Let us hope that the same Providence which has ordained that masses of plants, animals, or men, may not be unnaturally aggregated together without some disease becoming epidemic among them, may also in this case apply the same law for the destruction of the disease itself, by developing among its countless myriads of spores a principle of death, which may cause the plague to disappear as suddenly and mysteriously as it came.

Since the above was written, the blossoming season has proved so favourable that it is estimated that the crop for the year ending September, 1877, will exceed a million cwts., but whether the plants have suffered so seriously from the attacks of the "leaf disease" as to be unable to bring this crop to maturity time alone can prove.

June, 1876 R. ABBAY

OUR ASTRONOMICAL COLUMN

61 CYGNI.—The following formulæ for the difference of right ascension and declination of the components of 61 Cygni are founded upon a comparison of Bessel's measures with the Königsberg Heliometer (mean epoch, 1835·47) and Baron Dembowski's between 1871 and 1875, on forty-two nights:—

$$\Delta\alpha = +22''\cdot1727 + [8\cdot74148](t - 1870)$$
$$\Delta\delta = -7''\cdot4928 \quad [0\cdot27780](t - 1870)$$

If the angles of position and distances are calculated from the differences of right ascension and declination thus obtained for the epochs of the older observations, collected by Bessel in his earlier memoir, it will be found that there remains but a very doubtful deviation from rectilinear motion. Bradley's observations, 1753·8, exhibit the largest difference, 3″·9, but having regard to the discordance between the result from Piazzi's observations for 1806·3 and Bessel's for 1812·9, both of which can hardly be correct, this difference is not excessive. It appears that the only suspicion of curvature of path must depend upon these early and more uncertain data, as, indeed, was inferred by Mr. Wilson, of Rugby, some time since.

TUTTLE'S COMET.—The calculations of Clausen and Tischler have placed the theory of this comet upon a very satisfactory foundation. Discovered in the first instance by Mechain, at Paris, on January 9, 1790, it was observed until February 1; a parabolic orbit was computed by the discoverer, which subsequently figured in all our catalogues, but there appears not to have been at that time any suspicion of its comparatively short period; indeed, the short extent of observation might well prevent this. On January 4, 1858, the comet was re-detected by Mr. Tuttle, of the U.S. Navy, at the Observatory of Harvard College; the first elements calculated in this year presented so great a resemblance to Mechain's for the comet of 1790, that the identity of the bodies was immediately inferred, and successive approximations to the period of revolution by Pape and Bruhns, showed that in the sixty-eight years' interval there must have been performed several revolutions, the latter finally concluding that the comet had returned to perihelion four times since 1790, though on every occasion it passed unobserved. Clausen (Dorpat Observations, vol. xvi.) calculated the perturbations due to the attraction of Jupiter between 1858 and 1790, and thus carrying back the elements deduced from the observations of 1858 to 1790, found but small differences from those obtained from observation in the latter year, which difference was still further reduced after he had included the effect of Saturn's attraction from 1805, January 30, to 1816, August 24, and from 1831, July 17, to 1843, October 22. Tischler's results are published in his "Inaugural Dissertation"—*Ueber die Bahn von Tuttle's Comet*, Königsberg, 1868. In this able investigation of the young astronomer (who unfortunately lost his life before Metz) elements founded upon the observations of 1858 were used for the calculation of the perturbations, on the method adopted by Bessel for the comet of 1807, from 1858 to 1844, including the effect of Venus, the Earth, Mars, Jupiter, Saturn, and Uranus, and for all the remainder of the interval the effect of Jupiter and Saturn for every 100 days. With these perturbations of the first order, the elements were found for every 600th day, and with these

corrected figures the perturbations by Jupiter, Saturn and Uranus, were recalculated. Thus the value of the semi-axis major at perihelion passage in 1790 was determined. Tischler's work, however, did not close here; he subsequently computed the planetary perturbations from 1858 to the last perihelion passage towards the end of 1871, and hence derived elements for that appearance which were found amongst his papers after his death. It may perhaps be convenient, for the sake of reference, if Tischler's orbits for the three perihelion passages at which the comet has thus far been observed, are here transcribed:—

	1790	1858	1871
T	Jan. 30·8702	Feb. 23·5169	Nov. 30·4642
	° ′ ″	° ′ ″	° ′ ″
π ...	115 42 0	115 50 56	116 4 36
☊	268 36 34	269 3 4	269 17 12
i	54 6 26	54 24 30	54 17 0
ϕ	55 1 4	55 12 9·9	55 11 25·6
Log. a ..	0·7619723	0·7585361	0·7601603

The motion is direct. T is the time of perihelion passage for meridian of Greenwich; that for 1871 being the *predicted* time, which appears to have required a correction of $+ 1^{d}\cdot333$ nearly. ϕ is the angle of eccentricity ($e = \sin \phi$), and a the semi-axis major.

It is stated that the calculation of the perturbations of this comet to the next appearance in 1884 has been undertaken by Mr. Stone, of Washington.

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

M. DUMAS in his presidential address made some striking remarks on the important place filled by physical science in modern times as contrasted with its former supposed inferiority to literature, philosophy, and art. "Natural science is no longer content with the contemplative attitude which sufficed for Newton and Laplace. Science is now mixed up with all the personal acts of our existence; she interferes in all measures of public interest; industry owes to her its immense prosperity; agriculture is regenerated under her fostering care; commerce is forced to take her discoveries into account; the art of war has been transformed by her; politics is bound to admit her into its councils for the government of states. How could it be otherwise? Have not mechanics, physics, chemistry, the natural sciences, become intelligent and necessary agents for the creation of wealth by labour? Have they not opened the way to all the institutions by which hygiene watches over the health of workers and the salubrity of cities? If comfort is more universal, the life of man more prolonged, wealth better distributed, houses more commodious, furniture and clothing cheaper, the soldier better armed, the finances of the State more prosperous, is it not to the sciences that all this progress is due? It is they that discover in the ground the first new materials, that show to agriculture the most suitable productions, the most efficacious manures, and the most appropriate implements; they that, inventing new processes for industry, put into its hands untiring machines, sometimes gigantic, rivalling in brute force the giants of fable, sometimes delicate, rivalling in nimbleness the hands of fairies. It is the sciences, in fine, that have given to the world the rapid means of communication by land and sea, by the aid of which man takes possession of the terrestrial globe, creating new peoples and flourishing cities where our fathers knew only of barren deserts and uninhabited regions. . . . Science follows you everywhere: breathe, there is chemistry; walk, there is mechanics; at every moment, without thinking of it, we cannot help having to . . . her. Whether we wish it or not it is necessary to accept science as a companion, to possess her or to be possessed of her; if you are ignorant you are her slave, if you are skilled she obeys you. The future belongs to science; unfortunate are the people who shut their eyes to this truth."

The work of the various sections was carried on actively throughout the week, and a fair average of good papers seem to have been read, as usual, the section devoted to the medical sciences filling a large space. In the section of Anthropology, M. Tubino read an interesting paper on the Iberian Peninsula, in which he brought out strikingly the great differences which exist between the inhabitants of the various provinces of Spain and Portugal. There is found in the Spanish races no unity of origin or of physique. There is not only dissimilarity, but also antithesis and opposition. M. Tubino endeavoured to show that the same diversity existed in the region of morals, in language, in art, and in the ideas of right and law, and that thus there is really no Spanish race and no means of establishing in the Iberian Peninsula a centralised state. An interesting discussion followed in which M. Broca, while agreeing with M. Tubino's main statements, showed that the same diversities exist in every country that are found in Spain. The only great barriers of states are geographical limits; the idea of race is a delusion and a snare, and no doubt civilisation will come to Spain as it has come to France.

In the Botanical Section Prof. Lanessan explained the results of his organogenic and histologic researches on the foliar appendages of the *Rubiaceæ*. Prof. Haeckel spoke of some facts relative to the structure of the glands of some plants called carnivorous. The glands described by Darwin as dissolving and absorbing, are found on the inferior face of *Pinguicula* *[vul]garis* and of *Nuphar pumilum*, where they are unicellular. The cellules of these glands present the phenomenon of protoplasmic aggregation under the influence of slight solutions of ammoniacal salts (one-half per cent.). The same facts are presented in the glandular hairs of *Petunia Sparmannia*, and *Pelargonium*, which dissolve flesh after hypersecretion of the glands. He regards the phenomenon of protoplasmic aggregation as characteristic of absorption, and thinks that there will, perhaps, be room for distinguishing physiological aggregation from the morbid aggregation produced under larger doses of reagents. M. Merget explained the result of his researches in the production of phenomena of gaseous synthesis in vegetables.

An excursion was made on Tuesday morning to the top of the Puy-de-Dôme, in which most of the distinguished members of the Association, several ladies, and a number of English men of science took part. An excellent banquet was provided in a small valley at a short distance from the top. Eleven hundred guests had been invited by the Council-General; eight hundred were present. Many healths were proposed and speeches made.

The construction of the observatory cost 225,000 francs, and 100,000 more are required for the completion of the work, although it is in working order. The expenses have been sustained by the department, and the instruments have been constructed by the government. The house of the keeper and director is a massive building situated at a small distance from the top, and partly protected by rocks. Three lightning conductors have been adapted to it. The observatory is a tower standing on a platform, the communication between which and the house is by a well-staircase seventeen metres deep, and a tunnel thirty-five metres long. On the top of the tower is a movable platform. The view is magnificent, but special precautions will be required in constructing an anemometer which will be able to bear the pressure of the storms. It will be a self-registering one.

The concluding sitting of the session took place at the Hotel de Ville on Friday last, under the presidency of M. Dumas. M. Kuhlman was nominated vice-president for 1877 and president for 1878; M. Perier vice-secretary-

general for 1877 and secretary-general for 1878. The city for the meeting in 1878 has not been officially determined upon, but the intention of the committee is unanimously to propose Versailles or Paris, in order to take advantage of the interest created by the Universal Exposition.

The 1877 meeting will take place at Havre under the presidency of Dr. Broca, the celebrated anthropologist; M. De Lairain, the agricultural chemist, will be the general secretary.

The recommendations to Government have been few but interesting. The section of Mathematics asked the Government to give Commandant Perier and his fellow-workers the sum sufficient for continuing their present work of triangulating France. On Monday, the 21st, a lecture was delivered by M. Perier at the theatre on the geological work executed under his direction by staff officers, and the determination of the longitude of Puy-de-Dôme by electricity. The work is proceeding at the present time, and a temporary astronomical observatory has been established side by side with the meteorological one for that purpose.

The meteorological section asked government to organise a general issue of agricultural warnings (which M. Leverrier is preparing to do), to establish a national institute of meteorology, and to assist General Nansouty in the establishment of an observatory on the Pic du Midi, at an altitude exceeding by 3,000 feet the Puy-de-Dôme.

The "encouragements" to scientific workers are not determined by the General Meeting, but by the Council, according to the wants which may be made known from time to time during the year, and a report of the manner in which the money has been spent is presented yearly at the inaugural session of the Association.

NORDENSKIÖLD'S EXPEDITION TO JENISEJ, 1876

THE following plan of the expedition to the mouth of the Jenisej, fitted out by Messrs. Oscar Dickson, of Gothenburg, and Alexander Sibiriakoff, of St. Petersburg, has been published in the *Göteborgs Handels Tidning*:—

As it was desirable that the inquiries into the natural history of middle and north Siberia, and specially of the Jenisej valley should be recommenced during an earlier part of the year, a number of the members of the expedition were obliged, in the month of April, to travel by land *viâ* St. Petersburg, Moscow, Jekaterineburg, &c., to the town of Jeniseisk, thence to proceed down the river by boat to its mouth. For naturalists who had before made themselves familiar with the animal and plant world of northern Scandinavia, such a boat journey offered an excellent opportunity for comparative studies of the natural history of Siberia and Scandinavia, which will not only be of great moment for a knowledge of the flora and fauna both of Russia, and specially of Siberia and of Scandinavia, but also, as I have before pointed out, of true practical value in judging of the fitness of middle Siberia for cultivation. The land expedition is also entrusted with the task of carrying out the soundings necessary for ascertaining whether the Jenisej is navigable, and other hydrographical work, and specially of examining the navigable waters in the lower course of the Jenisej between Dudino and Mesenkin, in order to be able, on the arrival of the vessel at the last-named place, near the mouth of Jenisej, to pilot it to its proper destination, Dudino. I have given the leadership of this division of the expedition to Zoology-Docent Hj. Théel, from Upsala. Besides him there take part in it two botanists, Rector M. Brenner, from Helsingfors, and Docent H. W. Arnell, from Upsala, and two zoologists, Dr. J. Sahlberg, from Helsingfors, and Dr. F. Trybom, from Upsala.

It is, perhaps, already known through the newspapers that these gentlemen have arrived at Jeniseisk, and commenced the intended boat journey from that place to the mouth of the river.

For the main division of the expedition, which is to make its way by sea to Jenisej, I have chartered the steamer *Ymer*, of Gothenburg. The *Ymer* is a strong freight vessel, built of oak, of the first class in Veritas, of 400 tons burden, fully rigged with sails, and having a steam-engine of 45 horse-power. This part of the expedition is accompanied, besides the undersigned, by Docent F. Kjellman and Dr. A. Stuxberg, both members of the expedition of 1875, the former also of that which wintered in Mussel Bay in 1872-3.

The expedition now departing in the *Ymer* is not, as will be seen from the above, a commercial enterprise, but a scientific expedition, whose main object is to survey the navigable waters between Obi-Jenisej and northern Norway. But the Russian government having in the most accommodating way removed the obstacles which threatened to arise to the bringing in of goods to those regions where naturally no custom-house officers are to be found, I have considered that I ought, in order thereby practically to open the new commercial route, to take with me a small quantity of goods suitable for north Siberia, for the most part sent as samples by Swedish manufacturers, and, if opportunity offers, I shall also endeavour to obtain return cargo from Siberia to Europe.

During May, June, and the greater part of July, it is not possible to count on finding open water east of Novaya Zemlya, and it was therefore unnecessary for the *Ymer* to leave Sweden sooner than the beginning of July, the calculation being that she would enter the Kara Sea in the end of the month or the beginning of August. If all goes well the vessel ought in that case to be in a few days at Mesenkin, where a meeting has been fixed with Dr. Théel's party. If there be sufficient depth of water the voyage is to be continued to Dudino, where the cargo will be discharged and a new one taken on board.

By the end of August the *Ymer* ought to be again clear to return the way she came, possibly with some short excursion towards the north-east in order as far as possible without coming among ice to examine the sea between the mouth of the Jenisej and Cape Tscheluschkin. In the latter half of September I count on being again in Norway. A. E. NORDENSKIÖLD

NOTES

THERE is little to add in reference to the arrangements for the Glasgow meeting of the British Association to the information we published some weeks since (vol. xiv., p. 170). Everything has evidently been done by the local secretaries and committee to render the meeting a success so far as they are concerned. The class-rooms at the University, where the sections, with one exception—the Geographical—will be accommodated, have been for some time in the hands of workmen, and the necessary alterations will be completed in good time. The lower hall of the museum, which is situated a little to the east of the north or main entrance of the university, will be fitted up as the reception-room, and in connection with this will be the post and telegraph offices, general inquiry office, a stall for the disposal of newspapers and scientific literature. In this portion of the building there will also be located the offices and rooms of the local committee, and a ladies' retiring-room. Adjoining the reception-room will be the ticket-office, and from this will be the entrance to the refreshment-room. The sections will be distributed over the university, and the local committee contemplate issuing a diagram of the building, showing the class-rooms allotted to each department and their situation. The arrangements have been carried out so that the committee-rooms will adjoin all the sections. At the Queen's Rooms the arrangements are well forward for the accommodation of the Geographical Section.

MOST of the time of the International Congress of Orientalists which meets at St. Petersburg during the first ten days of September will be devoted to researches connected with Russian Asia. Of the four *séances* claimed for Asiatic Russia, we learn from the *Times* the first will belong to Eastern and Western Siberia, the second to Central Asia, so far as it is under Russian sway, together with the independent principalities of Ouzbekistan; in the third will be treated Caucasia, with the Crimea, and the other countries of European Russia which are inhabited by Asiatics; in the fourth, Trans-Caucasia (Georgia and Armenia, according to their ancient limits). In the three following *séances* the Congress will concern itself with the rest of Asia in three

groups—1. Eastern Turkestan, Tibet, Mongolia, including Mantchuria and Corea, China Proper, and Japan; 2. India Cis-Gangetic and Trans-Gangetic, Afghanistan, Persia, and the Indo-Chinese Archipelago; 3. Turkey, including Arabia and Egypt. The subjects to be treated in these seven *séances* are the cartography, ethnography, linguistic science, history, and literature of the respective countries. The last two *séances* will be devoted (1) to the questions relative to the archæology and numismatics, (2) to their religious and philosophical systems. An exhibition of objects illustrative of the antiquities and actual present condition of the Eastern peoples will be a novel and interesting feature. The Emperor of Russia has given to the St. Petersburg committee a sum of 75,000 roubles to defray the expenses of the meeting.

IN connection with the remarks on the influence of temperature on the herrings, in last week's NATURE (p. 352), we have read with much interest, in the *Scotsman* of August 25, the fishing report of the fishery district officer for North Sunderland. From this report it appears that for the week ending Saturday the 19th, the sea thermometers furnished to the fishermen by the Scottish Meteorological Society indicated a temperature on that coast of from 58° to 59°, but that on Monday evening, the 21st, when the nets were shot, the temperature had fallen to 55°, and this was the first night the herrings were caught. Since then the shoals of herrings have been so dense that several crews have sustained heavy loss by the weight of the herrings taking the nets to the bottom. The writer states that all this season during the warm weather the herrings were found low in the nets from Northumberland to Peterhead, and it was only when they came close upon the shore into shoal water, or from fifteen to eighteen fathoms, that the herrings were got. He thinks it premature to say that the Fraserburgh and Peterhead fishing will be a short one, as probably an inshore fishing, and a heavy one, may yet be made, the herrings having been approaching the shore at a depth below the nets. Evidently the remarkable weather and fishings of this herring season will furnish data for a contribution of no little interest to this difficult but important inquiry.

FROM a programme before us we gather that the exploration of the Cresswell Caves, carried on last year by the Rev. J. M. Mello, assisted by Mr. Heath, is now being conducted by a committee, of which Sir John Lubbock, Bart., M.P., is president, and Prof. Boyd Dawkins, F.R.S., is secretary. The superintendence of the work is in the hands of the Rev. J. M. Mello, the secretary, and Mr. Heath. The results are now being classified in Owens College, and we can confidently inform our readers that when the report by Mr. Mello and the secretary is presented to the Geological Society of London, it will add as much to our present knowledge of palæolithic man as the discoveries in Brixham did to the knowledge of 1857. The names of the members of the committee are a sufficient guarantee that the work will be carried out as well as it can be.

M. LEVERRIER has sent a circular to the several presidents of departmental councils notifying them that the Director of Government Telegraphy has agreed to send telegraphic messages to each head town of the departments (eighty-seven in number) if a proper organisation has been established to spread the warnings and to use them in the proper way. Departmental councils wishing to establish agricultural warnings are consequently to communicate with M. Leverrier, who will help them in doing so. The conditions required for the establishment of a departmental meteorological service are the appointment of a local meteorological board, which is to modify, according to local circumstances, the general information sent to the chief town, and to disseminate it in the several districts. The state telegraph circulates, free of charge, these local warnings. But in each district there must have been established a public barometer, thermometer, and rain-gauges, regularly inspected, verified, constructed according to the official pattern, and a competent local observer must have been appointed.

THE *Turkestan Messenger* states that M. Severtsow proposes to undertake, this autumn, a journey of exploration in the valley of Fergana and the neighbouring mountains. Next summer he will explore the Altai and the mountains of Southern Khokand, pushing on in the autumn of 1877 as far as the Pamir. M. Severtsow will be accompanied by an astronomer, a mining engineer, and a botanist.

THE steamship, which intends to cross with preserved meat from Buenos-Ayres, set sail from Rouen on August 23, M. Tellier, the inventor of the system, being on board. The cold is to be obtained in the hold of the ship by constant circulation of air, refrigerated by contact with tubes in which methylic ether is constantly evaporating.

THE Secretaries of the British Pharmaceutical Conference, whose thirteenth annual meeting commences at Glasgow on September 5, have already issued a list of papers which are promised for reading. We think it would be well if the British Association took a leaf out of the book of the Pharmaceutical Conference.

[illegible]ords of the Committee of Council on Education being of opinion that the subject of Physical Geography, as now defined in the Science Directory, is not one towards instruction in which the special aid of the Science and Art Department should be continued, intimate that the outlines of the syllabus of a subject which will take the place of physical geography, are now under consideration. The subject (physiography) will embrace those external relations and conditions of the earth which form the common basis of the sciences of nautical astronomy, geology, and biology, as treated in the Science Directory. At the same time it is proposed to allow payments for the next two years for those students who have already been under instruction by any science teacher in physical geography, but not for any others, nor for any examination held after May, 1878.

FROM the *American Journal of Microscopy* we learn that arrangements have been made with Prof. Huxley to deliver three lectures in New York on the 18th, 20th, and 22nd of September, the subject being "The Direct Evidence of Evolution."

MR. F. J. FARADAY, the Secretary of the Manchester Field Naturalists' and Archæologists' Society, has also been appointed Secretary to the Manchester Aquarium.

IN a pamphlet recently issued by the Russian Government, detailed statistics are given with reference to the damage done by wolves throughout that empire. There are said to be not less than 170,000 of these animals, which, during last year were the cause of death to not less than 200 people; whilst the destruction of cattle and poultry by them is enormous, almost as much as by the cattle-plague.

THE number of visitors to the Loan Collection of Scientific Apparatus during the week ending August 26 was as follows:—Monday, 2,926; Tuesday, 2,460; Wednesday, 323; Thursday, 305; Friday, 322; Saturday, 4,361; total, 10,697.

M. ABEL TRANSON, a Professor in the Polytechnic School, Paris, has died at the age of seventy years. He was the author of numerous memoirs in the *Journal de Mathématiques*, edited by Lionville. He had been successively a disciple of Saint Simon and Fourier, and had attracted public notice by the part he played in the propagation of these eccentric doctrines of social reform.

THE Paris Exposition of Practical Insectology was opened last Sunday on the terrace of the Tuileries Gardens, although the preparations are far from being completed. It promises to be an interesting and successful undertaking.

IT is well known that among the first enterprises in the form of original research undertaken by the Smithsonian Institution, was the organisation of a body of correspondents in meteorology for the purpose of securing reliable data in regard to the climatology of North America. This work was prosecuted as thoroughly as the means of the Institution would permit, and was conducted with unintermitting zeal from about 1848 until within a few years past, when the expenditure of ample means by the Signal Service for the same purpose rendered it unnecessary for the Institution to continue its efforts. A period of full twenty-five years or a quarter of a century is embraced in these records. The Institution has recently been engaged in working up and discussing these results for the purpose of obtaining reliable laws in regard to American climatology. Several years since this material was drawn upon by Prof. Coffin in the preparation of his work on the "Winds of the Northern Hemisphere," and published by the Smithsonian Institution. This was followed a few years subsequently by the publication of the table of rain-fall prepared by C. A. Schott. We now have to report the appearance of a third volume of the series, that of the "Atmospheric Temperature," forming a work of about 360 pages, illustrated by three plates, one showing the summer temperatures, one those of winter, and one the means of the year. The new edition of the work on the winds, commenced by Prof. Coffin, and finished after his death by his son, with the assistance of Prof. Wojeikoff, will, it is understood, make its appearance in a short time.

The fourth number of the second volume of the *Bulletin* of the Geological and Geographical Survey of the Territories is occupied by several zoological papers by Mr. J. A. Allen, of Cambridge. The most important of these is one upon "The Geographical Variation among North American Mammals, especially in respect to Size." Referring to the generalisation that was made some years ago, that the American Mammals as well as birds increase in size with the latitude of their birthplace, as also with altitude, Mr. Allen remarks that this does not apply in the case of some of the carnivora, and that the following propositions more nearly express the facts: 1. The maximum physical development of the individual is attained where the conditions of environment are most favourable to the life of the species. 2. The largest species of a group (genus, sub-family, or family, as the case may be) are found where the group to which they severally belong reaches its highest development, or where it has what may be termed its centre of distribution. 3. The most "typical," or most generalised representatives of a group are found also near its centre of distribution, outlying forms being generally more or less "aberrant" or specialised.

A COMMISSION composed of members of the Institute and other men of science has been appointed by M. Teisserene de Borg, the French Minister of Commerce and Agriculture, to draw up the regulations for the National School of Agriculture which has been re-established by a vote of the Senate. That establishment was abolished by Napoleon III. in the beginning of his reign; it was created by the French Republic of 1848.

M. NADAULT DE BUFFON, a French *savant*, has sent to the Society of Acclimatisation, through M. Drouyn de Lhuys, the herbarium collected by Daubenton, the great friend of his illustrious ancestor. The herbarium was collected at Montbard, when Daubenton was busy in the erection of a sheep-house, which led to the introduction into France of the first *merinos*.

A NOTEWORTHY feature in the *Iowa Weather Review* for June, No. 6, is the five weather maps accompanying it—one showing the position of the ninety-seven stations now established in the State, while the other four show the distribution of the rainfall during each of the three decades of May and during the whole month. Dr. Heinrichs aims at establishing other twenty-two stations in order to secure that the greatest distance between any two stations shall not reach fifty miles, and about 100 stations for rainfall and other non-instrumental observations which he properly regards as necessary for an accurate study of the atmospheric conditions of Iowa. A rapid summary of the weather of March, April, and May, with tabular matter, in several respects of an original and highly practical character, completes an interesting number.

WE have on our table the following books:—"The Law of Storms, considered Practically," W. H. Rosser (Charles Wilson). "The Yorkshire Lias," Ralph Tate and J. F. Blake (Van Voorst). "Wine and its Counterfeits," James L. Denman. "The Sun; Ruler of the Planetary System," third edition, Richard A. Proctor (Longman). Arnott's "Elements of Physics," seventh edition, edited by Bain and Taylor (Longmans). "The Andes and the Amazons," James Orton (Harper Brothers). "Comparative Zoology," James Orton (Harper Brothers). "On Mixed Languages," J. C. Clough (Longmans). "Weather Charts and Storm Warnings," R. H. Scott, F.R.S. (H. S. King and Co.). "Geological Survey of Canada for 1874-5." "Lectures on Astronomical Theories" (John Harris). "Dental Student's Note-Book," Oakley Coles (G. Butcher). "United States Geological Survey," Vols. ix. and x. The following German works may be had in London from Messrs. Williams and Norgate:—"Lehrbuch der Pathologischen Anatomie," von Dr. F. v. Birch-Hirschfeld, Erste Hälfte (Leipzig, F. C. W. Vogel); "Handbuch der Zoologie," von Gustav von Hayek (Wien, Carl Gerold's Sohn).

THE latest additions to the Royal Aquarium, Westminster, include the following:—John Dorey (*Zeus faber*), Scad, or Horse Mackerel (*Trachurus trachurus*), Small-mouthed Wrass (*Acantholabrus couchii*), Gemmeous Dragonets (*Callionymus lyra*), Sea Sticklebacks (*Gasterosteus spinachia*), Red Bream (*Pagellus centrodontus*), Three-bearded Rockling (*Motella mustela*), Large Spider Crabs (*Maia squinado*), Mexican Axolotl (*Axolotes guttatus*), presented by Mr. Jabez Hogg.

THE additions to the Zoological Society's Gardens during the past week include two Green Monkeys (*Cercopithecus callitrichus*) from West Africa, presented by Mr. Henry Richardson; a Sloth Bear (*Melursus labiatus*) from India, presented by Messrs. Royle and Gray, Lieutenants R.N.; two Russell's Vipers (*Vipera russellii*) from Ceylon, presented by Mr. Henry S. Saunders; three Dark green Snakes (*Zamenis atrovirens*), four Dahl's Snakes (*Zamenis dahlii*), a Clifford's Snake (*Zamenis cliffordi*) from Dalmatia, presented by Lord Lilford; a Hoffmann's Sloth (*Cholœpus hoffmanni*) from Panama, deposited; a Macaque Monkey (*Macacus cynomolgus*), born in the Gardens.

SCIENTIFIC SERIALS

PART 4 of vol. xxvi. of the *Zeitschrift fur Wissenschaftliche Zoologie* (March, 1876) opens with a long communication from O. Bütschli on the free Nematodes and on the Gastrotrichous genus Chætonotus. He gives many additional particulars respecting forms already made known by Bastian and others. He comes to the conclusion that the Gastrotricha are intimately related to Dujardin's genus Echinoderes; and he combines them into a group Nematorhyncha. He then considers the relations of these forms to Vermes and Arthropods, and constructs a supposed phylogenetic tree. The paper is beautifully illustrated.—Dr. Hermann von Ihering has a controversial article on the development of Cyclas and the homology of the blastodermic

layers in Mollusca. He especially calls in question the observations of Ray Lankester, Haeckel, and Ganin, and approves the modified form of the Gastræa theory no more than the original.—F. E. Helm describes in detail the silk-glands of Lepidoptera, and their retrogressive changes after full function.—Herbert Ludwig, giving an account of the formation of the blastoderm of spiders, states that his observations are in entire accordance with Haeckel's views.

Gegenbaur's Morphologisches Jahrbuch.—Part 3 opens with a long and important communication by Oscar Hertwig on the formation, fecundation, and division of the ovum in the Echinid *Toxopneustes lividus*. He considers chiefly the fate of the germinal vesicle and the connection between it and the subsequent development of the ovum. From his observations he supposes that when the germinal vesicle is resolved the germinal spot is saved and gets to the centre of the ovum; he finds that a nuclear body which may be the head of the spermatozoon approaches this and coalesces with it, and that the resulting body assumes an hour-glass shape and finally divides into two, and really originates the cleavage of the ovum. Unfortunately the author has to make assumptions at the most critical points, and consequently his views cannot be accepted without confirmation.—Dr. G. Born has a contribution on the sixth toe of Anura, referring to the cartilages considered by Cuvier and Meckel as a rudiment of a sixth member of the hind limb. Another lengthy memoir in this part is by R. Wiedersheim on the anatomy of *Phyllodactylus europæus*, a member of the group of lizards of which the gecko is the type, found in the Island of Sardinia, as well as in the islet Tinetto, on the western horn of the Gulf of Spezia. He considers very fully the relation of the *aquæductus vestibuli* to the *sacculus endolymphaticus* in the Ascalabota generally.

In Part 4 Dr. B. Gabriel describes a new genus and species of Rhizopod living in moist earth about the roots of mosses. This form, which he names *Troglodytes zoster*, has a shell-like investment and emits pseudopodia at one pole only. The life-history of this form has been traced, and it is of great interest. Two adult specimens conjugate by their pseudopodia and afterwards separate; this is followed by an encysted stage, during which a large number of minute granules grow up into germs which are liberated from the investment, and grow up into a minute monostigma form. These germs subsequently conjugate in pairs constituting a diplostigma, and ultimately they slowly coalesce, and then assume the parent form.—T. W. Engelmann has an elaborate article on development and reproduction in Infusoria, in which he gives an account of the stages of *Opalina ranarum* and of budding and conjugation in Vorticella and Epistylis. He further examines and criticises many observations of other authors, and some of his principal conclusions are as follows:—That the conjugation of Infusoria does not lead to reproduction by means of ova, but to a peculiar development of the conjugated individuals, which he terms reorganisation; that the nucleus, neither in conjugation nor in any other circumstance, plays the part of a germ-producing organ; that its significance is merely that of an ordinary cell-nucleus.—Max Furbringer continues his monograph on the comparative anatomy of the shoulder-muscles, by a chapter of 180 pages, on the bony shoulder-girdle and sternum, the brachial plexus, and the muscles related to the shoulder in Lacertilia and Crocodilia.

SOCIETIES AND ACADEMIES

PHILADELPHIA

Academy of Natural Sciences.—Session 1875-6.—Prof. Cope's contributions to palæontology and philosophic biology have been numerous and important. In successive communications he has given accounts of the Eocene mammals of the Rocky Mountains, possessing characters which at first led to their being assigned to the Carnivora. Prof. Cope has demonstrated their insectivorous affinities, but finds that the definition of existing insectivora is insufficient to include them. Other forms supposed at first to be of lemurine affinities are found to be yet more generalised, and to range with the previously mentioned animals. He proposes the name Bunotheria for the order, with sub-orders Creodonta, Mesodonta, Insectivora, Tillodonta, and Tæniodonta (*Proc.* 1876, p. 88). Prof. Cope has also endeavoured to equate the North American Eocene to the European zones. The Bridger formation of S.W. Wyoming he calls Middle Eocene, characterised by Palæosyops, Tillodonta, and Dinocerata; and the Wahsatch group in N.E. New Mexico and S.W. Wyoming is assigned to the Lower Eocene, with Coryphodon, Tæniodonta, Phenacodus, and Diatryma.—Mr. Robert Ridgway contributed (*Proc.* 1875, p. 470) a valuable monograph on the North American hawks of the genus Micrastur. An examination of the perplexingly-various plumage shows that there is no appreciable sexual difference; there are two well marked growth-stages with plumage distinctions; certain species are notably dimorphous, some deeply rufescent, others clear plumbeous, without reference to age, sex, or season.—Other contributions to zoology include the establishment of a new genus of Procyonidæ from Costa Rica, by Mr. J. A. Allen; observations on the habits of manatees kept in confinement in the Zoological Garden at Philadelphia, by Dr. H. C. Chapman; Dr. Wilder on fishes' brains, and Prof. Leidy on Rhizopods, and Mr. H. K. Morrison on American Noctuidæ.—Dr. Isaac Lea has continued his researches on the microscopic structure of gems, and has found that in addition to the internal crystalline forms which they possess, there are in most gems, cavities, often tens of thousands in number.—Mr. George Hay, in his chemical contributions gives an account of the decomposition of stannous chloride vapour in a Geissler's tube; and of the solubility of tin, arsenic, and antimony in concentrated nitric acid at 36° F., when the oxidation is in the ratio of their several volatilities.—Prof. Persifor Frazer and Dr. Kœnig have been the principal contributors in geology and mineralogy.—Mr. Thomas Meehan among several botanical notices has given accounts of interesting hybrids, of certain insectivorous plants, and of a certain maple tree which flourished although all its leaves became reversed, so as to expose its stomata to direct sunlight. The propagation of *Tillandsia usneoides*, the epiphytic, not parasitic Florida or Spanish moss was described as being principally by means of small branches scattered during storms or by other means, but very rarely by seeds.—An interesting observation was made on the large number of cases in which double Chinese peaches of the season 1875 bore two or three fruits on each flower; thus showing their solidarity with the polycarpellary Rosaceæ.

VIENNA

Imperial Academy of Sciences, March 9.—On the nature of the soft or half liquid state of aggregation; on regelation and recrystallisation, by M. Pfaundler. After dividing the bodies in question into mixtures of small solid parts with true liquids, soft bodies proper, containing no dissimilar parts, and mixtures of the two classes, he gives a hypothesis on the process of melting and the soft state. The common ideal melting process, where the temperature remains the same from beginning to end, is not according to fact. The mean temperature of the body beginning to melt is about $t + t'$ lower than that of the already melted mass, if $\pm t$ and $\pm t'$ denote the amounts of divergence of temperature of the separate molecules in the solid and liquid condition. Hence the true melting point is different from the temperature at the beginning and the end of the melting process. M. Pfaundler extends his hypothesis to soft bodies of compound nature, and to regelation and recrystallisation.—On the difference of tension between the left ventricle and the aorta, by M. Gradle. The blood pressure in the aorta is usually higher than the maximal pressure in the left ventricle. The difference disappears when the points of the semilunar valves are torn through.—On the physical nature of vegetable protoplasm, by M. Velten. The retention of form (in hair cells, leaf cells, &c.) and simultaneous mobility of particles, indicate that at least two bodies with different aggregate states exist in protoplasm. The dense parts do not envelop the liquid parts, but solid and liquid particles are arranged beside each other in small spaces. In considering the ball formation of plasma, which is the principal argument for its liquid nature, M. Velten distinguishes normal and abnormal ball formations; the former could not prove the viscous nature of plasma, while the latter unmistakeably point to a semi-liquid state of aggregation of the whole body.—On nitro-glycerine and the most important nitro-glycerine preparations, by M. Beckerhin.—On the condition of heat equilibrium of a system of bodies with reference to gravity, by M. Loschmidt. Gravitation affects only the vertical component of molecular velocity, leaving the horizontal untouched; this destroys the symmetry of distribution of velocity in gases.—Communications from the Mineralogical Museum of the University, by M. Schrauf. This relates to certain minerals from the graphite deposits of Mugrau.

March 16.—On the influence of temperature on galvanic conduction of tellurium, by M. Exner. The alteration of conductivity through heat is due to a change of molecular structure;

thus too are explained the turning points Matthiessen found in the curve representing resistances of tellurium at different temperatures.—On the geometric-symmetric forms of the earth's surface, by M. Boué. The rotation force of the earth forbids comparison of the clefts on its surface to those of a clay-lump produced by contraction. The earth took its present form under several forces, especially the centrifugal force of rotation, wave-motion of the still plastic and hot zones under the crust, and infiltration of water. The orography of the earth is somewhat similar to a chess-board.—On the relation of the coefficient of internal friction of gases to temperature, by M. Obermayer. The coefficient of friction of the permanent gases is approximately proportional to the $\frac{3}{4}$ power of that of the coercible gases, and to the 1 power of the absolute temperature.—Researches on the relations of nutritive matters to transpiration of plants (first part), by M. Wiesner. Dilute acids accelerate, dilute alkalies retard, the transpiration. Very dilute solutions of the salts that were employed (0·05, 0·1, 0·2, 0·25 per cent.) accelerate the transpiration; more concentrated solutions (0·5, 1 per cent.) retard it. In solutions of nutritive matter, even with such a degree of concentration as, where solutions of the separate salts were used, accelerated the transpiration, the latter was less than in distilled water. Aqueous humus extracts also diminish the transpiration.

March 23.—On elevation of animal temperature after section of the spinal cord, by M. Schroff.—New propositions of the mechanical theory of heat (second part); on forces determining the volume of bodies, by M. Puschl. Theory leads him to conclude, that at the end of a cycle-process in a body, not only the heat, but also the other forms of force present and jointly determining its volume have done a positive or negative external work. The results of Edlund's experiments on the heating of contracting metallic wires are a first experimental proof of this theoretical deduction.—On æthyl propylcarbinol, by M. Volker.—On the ground-forms of linear geometry, by M. Frombeck.

April 20.—The principle of dissimilar molecular states applied in explanation of supersaturated solutions, superfused bodies, retardation of boiling, spontaneous explosions, and crystallisation of amorphous bodies, by M. Pfaundler.—The theoretical basis of the Foucault pendulum experiment, by M. Pick.

Geneva

Physical and Natural History Society, May 4.—Prof. F. A. Forel, of Morges, described the traces obtained by him in his native town, situated on the north shore of the Lake of Geneva, by means of a registering limnimetre. This automatic apparatus indicates constantly the height of the water of the lake on an endless paper band, which is unfolded at a rate of about a millimetre per second, by means of clock-work. By means of the tracings thus obtained may be investigated the oscillations of level known as *seiches*. M. Forel has thus verified, in a very satisfactory manner, the theory which maintains that these *seiches* are rhythmic isochronous movements, waves of fixed oscillation (the stationary, mononodal waves of Guthrie). He proves that the water of lakes oscillates almost constantly from one bank to the other, and that in two principal directions, along the great axis and along the smaller diameter of their surface. These two movements, which are often simultaneous, are what M. Forel calls longitudinal *seiches* (lasting for seventy minutes on the Lake of Geneva) and transversal *seiches* (ten minutes induration). The comparison of these tracings with meteorological circumstances will show what relations exist between the movements of the *seiches* and the variation of atmospheric pressure.

Paris

Academy of Sciences, Aug. 21.—Vice-Admiral Paris in the chair.—The following papers were read:—Meridian observations of small planets, made at the Observatory of Greenwich (sent by the Astronomer-Royal, Sir G. B. Airy) and at the Paris Observatory, during the second trimestre of 1876, by M. Le Verrier.—Theorems relating to curves of any order and class, in which are considered couples of rectilinear segments having a constant length; examples of the variety of different solutions furnished, in each question by the principle of correspondence, by M. Chasles.—Thermal formation of hydroxylamine or oxyammonia, by M. Berthelot. Thermal observations confirm and define the unstable properties of oxyammonia, an instability due to the exothermal character of its different modes of decomposition.—An effect of lightning during the storm of Aug. 18, by M. Trécul. While writing at his open window between seven and eight A.M. he observed, simultaneously with some loud thunder, small luminous columns descending obliquely on his paper; about 2 metres long, $1\frac{1}{2}$ decimetre broad at the widest part, obtuse at the further end, but gradually thinning towards the table. They had mostly a reddish yellow tint; near the paper the colours were more intense and varied. In being extinguished, they left the paper with a slight noise like that made by pouring a little water on a hot plate. M. Trécul felt no bad effects.—Results obtained by the treatment of phylloxerised vines, by means of sulpho-carbonates and the distributing pale, by M. Allibert.—On the invasion of winged phylloxeras at Mancey (Saône-et-Loire) on June 25. They deposit their pupæ in the down of the leaves. Four or five could be counted on a single leaf.—Observations of the planet (165) Peters, made with the equatorial of Paris Observatory, by MM. Paul and Prosper Henry.—Observations of planet (165) at Leipsic, by M. Bruhns.—Discovery of the planet (166); despatch from Mr. Joseph Henry, of Washington, to M. Leverrier.—Electric regulator to maintain the motion of pendulum, by M. Bourbouze. To the upper part of the pendulum is fixed a magnetised bar which can oscillate freely within a rectangular bobbin with two wires like that of a galvanometer. At each oscillation a current of constant intensity is passed into the bobbin, but alternately in different directions; and this maintains the motion. The reversal is effected by means of a beam having at each of its ends a bridge which dips in two cups containing mercury.—On chaplet (or beaded) flashes of lightning, by M. Planté. This name is given to a phenomenon observed in Paris on Aug. 18. The lightning, coming from the cloud to the ground, described a curve like an elongated S, having the aspect of a chaplet of brilliant grains along a very thin luminous thread. This results from passage of the electric fluid through a ponderable medium. The case is analogous to that of the chaplet of incandescent globules presented by a long metallic wire fused by a voltaic current, or to the swellings and nodes in the flow of any liquid vein. Such agglomerations, naturally, are dissipated more slowly than the line collecting them. We have here a transition form of lightning between that of the ordinary sinuous and straight lines and the globular form. Fulminating globes may be considered as derived from a chaplet flash.—On equivalent substitution of mineral matters which enter into the composition of plants and animals, by MM. Champion and Pellet. In the ashes of flesh of different animals and hen's eggs the phosphoric acid is nearly constant, as also the quantity of acid capable of saturating the bases. With different compositions of ashes the weight of sulphuric acid saturating the bases is higher the more there are of bases with small equivalents. The ashes of veal contain more soda than those of beef, so do those of hen's eggs and the adult hen.—On the fermentation of urine; reply to M. Pasteur, by Prof. Bastian. M. Pasteur explains his negative result by the potash having been heated to 110° C., Prof. Bastian only by the fact that the potash has been added in excess. That all Bacteria germs are killed in potash solutions heated to 100° appears from two facts: (1) boiled potash solution has not a fertilising influence if only two or three drops of it be added to a demilitre, at least, of boiled urine; (2) the boiled potash solution is also inactive if it be introduced in strong enough proportion to render the boiled urine a little alkaline.—Researches on the gases contained in fruits of the bladder-nut tree, by MM. Saintpierre and Magnien.—Observations of falling stars during the nights of August 9, 10, and 11, by M. Chapelas.

CONTENTS

THURSDAY, SEPTEMBER 7, 1876

SCIENTIFIC WORTHIES

IX.—Sir William Thomson.

SIR WILLIAM THOMSON was born in Belfast in June 1824. His father, Dr. James Thomson, was a very remarkable man. The family of Thomsons had for several generations occupied a farm near Ballynahinch, in County Down, Ireland; but James Thomson, when quite a boy, endeavouring all alone to understand the principles of dialling, was led into the study of mathematics, for which it soon appeared that he possessed an extraordinary capacity. His father then permitted him to go to a small classical and mathematical school at his native place, and there he was soon promoted to be an assistant teacher. Without ceasing to labour as a teacher for his own support, he became a student in the University of Glasgow, attending there during the winter months, and teaching at Ballynahinch during the summer.

When he had nearly completed his fifth year at Glasgow, he was appointed Headmaster of the School of Arithmetic and Geography at the Royal Belfast Academical Institution, and subsequently Professor of Mathematics in that Institution. In 1832 he was appointed Professor of Mathematics in the University of Glasgow, and removed thither with his family. He was the discoverer of many improvements in algebra and in the calculus, and in particular, he was the first to apply systematically Horner's method of solving algebraic equations to the arithmetical extraction of cube roots and higher roots of numbers. He was also the author of several important educational works which have come extensively into use; and besides excelling in science, he was highly accomplished in classical and in general literature. But he is perhaps better remembered in Scotland for his success as a teacher; and those who were his pupils speak with delight of his voluntary catechetical hours, in which *vivâ voce* questions were proposed and rapidly passed from bench to bench in a class of ready and enthusiastic pupils.

There are many who remember among the readiest and the most enthusiastic, a little lad of eleven or twelve years of age who could scarcely make himself seen among his older class fellows. This was William Thomson, who at that early age had entered the University; and who even then distinguished himself greatly for originality and high mathematical ability. Having passed through Glasgow University he entered St. Peter's College, Cambridge. In 1845 he graduated as second wrangler and first Smith's Prizeman, and was immediately elected a Fellow of his college. While he was at Cambridge he was remarkable for his scholarly attainments in science and in literature. He won the Colquhoun, and was for some time president of the Cambridge University Musical Society.

After completing his undergraduate course at Cambridge he went to Paris, and spent some time working in the laboratory of Regnault, who was then engaged in some of his most important researches. After the death of Dr. Meikleham he became a candidate for the Chair of Natural Philosophy in the University of Glasgow, and was elected. Thus in 1846, at the early age of twenty-two, he was appointed to the Chair which he has filled with such distinction, and still holds.

Sir W. Thomson's earliest contributions to physical science were a defence of Fourier in answer to a charge of erroneousness which had been brought against some of the fundamental formulas of his harmonic analysis, and a paper on "The Uniform Motion of Heat in Homogeneous Solid Bodies, and its Connection with the Mathematical Theory of Electricity." These were written at the age of seventeen. They were published in 1841 and 1842 in the *Cambridge and Dublin Mathematical Journal*. The latter paper is a very remarkable one: its spirit runs through much of Sir William Thomson's subsequent work. He points out in it the analogy between the theory of the conduction of heat in solid bodies and the theory of electric and magnetic attraction; and, aiding himself with this analogy, he makes use of known theorems as to the conduction of heat in order to establish some of the most important theorems in the mathematical theory of electricity. The method was thoroughly original; and later, taken in conjunction with Faraday's admirable researches on electrostatic induction, which led to the discovery of differences in the specific inductive capacity of various substances, and to the notion of *conduction of lines of force*, it proved of the highest value in the discussion of questions in electrostatics and also in magnetism. As to the results obtained, Thomson found, a few months after, that in some of the most important he had been anticipated by M. Chasles. Later he found that Gauss had given the same general theorems shortly before Chasles independently rediscovered them; and, three years after, having heard of a paper by Green, but long inquired for it in vain, he found, on obtaining a copy of that paper, that all these theorems had been discovered and published in the most complete and general manner, with rich applications to the theory of electricity and magnetism, as early as 1828. This memoir of George Green, of Nottingham, was printed privately, dedicated to his patron the Duke of Newcastle, and it lay unread and unknown till 1845, when Thomson obtained a copy, made known what a mine of wealth it contained, and had it republished in *Crelle's Mathematical Journal*.

Another very important paper written about the same time, and published in the *Cambridge and Dublin Mathematical Journal* for 1842, was on the "Linear Motion of Heat." It contained the foundation of the method of evaluating absolute geological dates from underground temperature, which he made the subject of his inaugural address on his institution to his professorship in the University, and which we believe forms a large part of the subject of his opening address to the Mathematical Section of the British Association.

The papers referred to were followed by a paper on the "Elementary Laws of Statical Electricity," which first appeared in *Liouville's Journal de Mathématiques*, in 1845, and was translated and published the same year in the *Cambridge and Dublin Mathematical Journal*. Sir W. Snow Harris had undertaken an experimental examination of the fundamental laws of electric attraction and repulsion; and his results, which received the Copley Medal of the Royal

Society, were at the time supposed to disprove the well-known laws first given by Coulomb. Thomson, however, at the age of twenty-one, undertook the examination of the results of Snow Harris, and showed that, instead of being out of harmony with the laws of Coulomb, they were, so far as they went, confirmatory of those laws. He pointed out clearly the precautions necessary in experiments on the elementary laws, and he showed that it was through a misunderstanding as to the conditions of the simple laws enunciated by Coulomb that Snow Harris was led into error. In this memoir we find also the first steps towards making Faraday's new theory of induction the basis of the mathematical theory of electricity. In subsequent papers this method of proceeding to the mathematical theory is completely worked out; and, reading together the memoirs of Faraday and of Thomson, we cannot help being struck with the way in which the notion of lines of force and lines of flow of heat fascinated the minds and guided the intuition of our two greatest investigators.

We cannot here follow Sir William Thomson in detail through his series of papers on electrostatics and on magnetism. They were collected and published in 1872, with notes and most important additions, in a volume of 600 pages. It is greatly to be desired that the same may be done for the very numerous memoirs on other physical subjects with which he has enriched the *Transactions* and *Proceedings* of a host of learned Societies.

In 1846 Mr. Thomson became editor of the *Cambridge and Dublin Mathematical Journal*, a post which he held for about seven years. Among the contributors to the journal during his editorship he could count Stokes, Cayley, De Morgan, Liouville, Salmon, Sir William Rowan Hamilton, and many other distinguished mathematicians; while from his own pen proceeded many memoirs of great importance. It was about this time, also, that he contributed to *Liouville's Journal de Mathématiques* the memoirs in which he unfolded his principle of "electric images." By means of this principle, which he in his first letter likens to Brewster's kaleidoscope, he shows how, by simple geometrical principles, to solve many problems of an apparently very complicated nature, as to the distribution of electricity on a system of conductors under the influence of a given electrified system. The veteran Liouville, concluding a note suggested by the letters of Mr. Thomson, writes of his own developments of the theory: "Mon but sera rempli, je le répète, s'ils peuvent aider à bien faire comprendre la haute importance du travail de ce jeune géomètre, et si M. Thomson lui-même veut bien y voir une preuve nouvelle de l'amitié que je lui porte et de l'estime que j'ai pour son talent."

His electrostatic researches led Thomson to the invention of very beautiful instruments for electrostatic measurement. The subject of electrostatic measurement occupied much of his attention from the very earliest, when he was obliged to call attention to the defects of the electrometers of Snow Harris. His labours in this direction have produced the quadrant electrometer, which is employed for all kinds of electric testing in telegraph construction, and for the registration of atmospheric electricity at Kew Observatory; the portable electrometer, for atmospheric electricity and for other purposes in which the extreme sensitiveness of the quadrant-electrometer is not required; and the *absolute* electrometer, which serves for reducing the scale readings of other instruments to absolute measure, and which was used by Thomson in his measurement of the electrostatic force producible by a Daniell's battery and in many other investigations. Those who have seen the collection of electrometers in the Loan Collection at South Kensington will not think it too much to say that to Sir W. Thomson is due our present system of practical electrometry.

But while thus engaged in investigations in electrostatics and magnetism, there were many other branches of science that were receiving from him advancement in a not less remarkable way. There is no part of his work of higher importance than his investigations on the Dynamical Theory of Heat. These were communicated in a series of papers to the Royal Society of Edinburgh, the first of which was given in 1849. It was a critical account of Carnot's memoir of 1824, "Réflexions sur la Puissance Motrice du Feu." Though Rumford and Davy had, in the beginning of this century, experimentally disproved the material theory of heat, their experiments and arguments were unheeded and nearly unknown; and it was only after 1843, when Joule actually determined the dynamical equivalent of heat, that the great truth that heat is a mode of motion was admitted and appreciated. Thus Carnot, although dissatisfied with it, was obliged to adopt the material theory of heat in 1824; and, regarding heat as indestructible, spoke of the letting down of the heat from a higher to a lower temperature, and looked on the production of work by the heat engine as a phenomenon analogous to that in which water, descending from a higher to a lower level, does work by means of a water-wheel. Thomson, among the first to appreciate the importance of Joule's results, set himself to alter the theory given by Carnot into agreement with the true theory; and in the series of papers referred to, placed the whole science of Thermodynamics on a thoroughly scientific basis. In 1846 he first suggested the reckoning of temperature on an absolute thermodynamic scale independent of the properties of any particular substance. Subsequently, in consequence of experimental investigations of the thermodynamic properties of air, and other gases, made in conjunction with Joule, he showed how to define a thermodynamic scale of temperature having the convenient property that air thermometers and other gas thermometers agree with it as closely as they agree with one another. This system of reckoning temperature gives great facility for the simple expression of thermodynamic principles and results.

Having here mentioned Joule and Thomson together, we cannot omit to remark that some of the most admirable researches in thermodynamics were those undertaken in conjunction by these two attached friends.

Among the many important results of Sir W. Thomson's investigations in thermodynamics, one of the most remarkable was his discovery of the principle of dissipation of energy, announced by him in 1852. During any transformation of energy of one form into energy of another form there is always a certain amount of energy rendered unavailable for further useful application. No known process in nature is exactly reversible, that is to say, there is no known process by which we can convert

a given amount of energy of one form into energy of another form, and then, reversing the process, reconvert the energy of the second form thus obtained into the *original quantity* of energy of the first form. In fact, during any transformation of energy from one form into another, there is always a certain portion of the energy changed into heat in the process of conversion; and the heat thus produced becomes dissipated and diffused by radiation and conduction.

Consequently there is a tendency in nature for all the energy in the universe, of whatever kind it be, gradually to assume the form of heat, and, having done so, to become equally diffused. Now, were all the energy of the universe converted into uniformly diffused heat, it would cease to be available for producing mechanical effect, since for that purpose we must have a hot *source* and a cooler *condenser*. This gradual degradation of energy is perpetually going on; and sooner or later, unless there be some restorative power, of which we at present have no knowledge whatever, the present state of things must come to an end.

We must pass very briefly over a large number of Sir W. Thomson's contributions to science that, were our limits less circumscribed, we would gladly dwell upon. In 1855 his paper on "Electrodynamics of Qualities of Metals" was made the Bakerian Lecture for the year. This paper represents a marvellous amount of ingenuity and labour and contains, most valuable new results that, strange to say, are only now beginning to be known. In it was announced his discovery of the electric convection of heat, and a great number of most important new relations between thermal and electric properties of matter. It is interesting to remark that it was while engaged in these investigations that Thomson first called in the experimental aid of his students, and thus made a beginning of the Glasgow Physical Laboratory.

We can do no more than mention here Sir William Thomson's *proof* of electricity of contact, his calculation of the size of atoms, his memoir on the mechanical energies of the solar system, his determination of the rigidity of the earth, his researches on the tides in connection with a British Association Committee on that subject, and his recent splendid researches on vortex motion, as we have still to refer to his connection with submarine telegraphy.

In 1854 Faraday, with an experimental cable, investigated the cause of the *retardation of signals* first observed in the working of the cable between Harwich and the Hague. Thomson, taking up the question published an investigation of the nature of the phenomenon, one practical result of which was that with cables similar in lateral dimensions the retardations are proportional to the *squares of the lengths*. This law is now commonly referred to as the "law of squares." About this time it was proposed to construct a cable to connect England with America; and it became obvious that the discovery of the retardation of signals raised a question whether the transatlantic cable would not prove a commercial failure. Whitehouse, experimenting with 1,125 miles of cable, found the transmission of an instantaneous signal to the farther end of the cable to occupy one second and a half. The length of a cable required to connect Ireland with Newfoundland is twice that of the experimental cable of Whitehouse; and thus, according to the law of squares, the time taken to transmit an instantaneous signal through a cable similar in lateral dimensions to that of Whitehouse, and joining those two places, would be no less than *six seconds*. In 1856 Whitehouse read a paper before the British Association, in which he described experiments by which he hoped to disprove the law of squares. Thomson replied in the *Athenæum* (Nov. 1, 1856); and subsequent experiments have established the correctness of his law.

Fortunately a true understanding of the nature of the phenomenon of retardation led Prof. Thomson to the method of overcoming the difficulties presented. The disturbance produced at the extremity of a long submarine cable by the application for an instant of electromotive force at the other end is not, as in the case of a signal through an overhead land-line, a pulse, practically infinitely short, and received only a minute fraction of a second after it was communicated. Instead of this, a long wave is observed at the farther extremity, gradually swelling in intensity, and as gradually dying away. Its duration for such a cable as we have been speaking of would be the whole six seconds, calculated from the experiments of Whitehouse. Prof. Thomson perceived that an instrument was required which should give an indication of a signal received long before the wave has acquired its maximum intensity, and in which the subsequent rising to maximum intensity should not render unreadable a fresh signal sent quickly after the previous one. This was effected by his "mirror galvanometer"; and it was by means of it that the messages transmitted through the 1858 Atlantic cable were read.

The 1858 cable, submerged under difficulties that many times threatened to be insurmountable, soon failed. Several important messages were, however, transmitted through it; and it served to *prove* the feasibility of the project which many eminent engineers up till that time regarded as chimerical. Before another attempt was made the labours of Prof. Thomson and others, to all of whom the world owes a deep debt of gratitude, had so improved the construction of the cables and the mechanical arrangements for submersion, that though many difficulties presented themselves they were all, in 1866, triumphantly overcome. It was on his return from the submersion of the 1866 cable, and the raising and the completion of the 1865 cable, that the honour of knighthood was conferred on him along with others of his distinguished fellow-workers.

Recently Sir William Thomson has invented a new and very beautiful instrument, the "siphon recorder," for recording signals on long submarine lines. It is in use at all the telegraph stations along the submarine line connecting England with India. It is also used on the French Atlantic Cable, and on the direct United States line. Sir W. Thomson, Mr. Varley, and Prof. Jenkin, combining their inventions together, have given the only system by which submarine telegraphy on long lines has been carried on up to the present time.

Sir William Thomson is an enthusiastic yachtsman and a skilful navigator. His recently-published popular lecture on Navigation proves this; and, with that bright genius which enriches all with which it comes in contact, his improvements in navigation, as we had occasion to

remark a fortnight ago, in noticing his newly published "Tables for Facilitating the Use of Sumner's Method at Sea," are of very high importance. The general adoption of Sumner's Method, now made simple for the navigator, would be a reform in navigation almost amounting to a revolution, and is one most highly to be desired. Sir William Thomson has also invented a new form of mariner's compass of exquisite construction. It possesses many advantages over the best of those in general use, not excluding the Standard Admiralty Compass; but its special feature is that it permits of the *practical* application of Sir George Airy's method of correcting compasses for the permanent and temporary magnetism of iron ships. He has also invented an apparatus for deep-sea sounding by pianoforte wire. This apparatus is so simple and easily managed that he has brought up "bottom" from a depth of nearly three nautical miles, sounding from his own yacht, without aid of steam or any of the ordinary requisites for such depths. His method was much employed in taking rapid soundings during the laying of telegraph cables along the Brazilian coast to the West Indies. It has also been used with great success on the United States Submarine Survey. Recently, while on his way to Philadelphia, Sir W. Thomson himself was able to take flying soundings, reaching the bottom in 68 fathoms, from a Cunard Line steamship going at full speed.

The treatise on "Natural Philosophy" written by Prof. Thomson, in conjunction with Prof. Tait, brings before us another branch of activity in which he has shown himself as eminent as in research.

Sir William Thomson is a Fellow of the Royal Society of London and of the Royal Society of Edinburgh. He has received the Royal Medal of the former and the Keith Medal of the latter. He is also an honorary member of several foreign societies. The Universities of Dublin, of Cambridge, and of Edinburgh have each conferred upon him the honorary degree of LL.D., and that of Oxford the honorary degree of D.C.L. On his marriage in 1852 he gave up his Fellowship at St. Peter's College, Cambridge; but in 1871 his college again elected him to a Fellowship, which he now holds.

Sir William Thomson's brother, Dr. James Thomson, is Professor of Civil Engineering in the University of Glasgow. He is well known as the discoverer of the lowering of the freezing-point of water by pressure; and is the author of many other important physical researches.

The following opinion of Sir William Thomson's merit as a worker in science has been sent us by Prof. Helmholtz:—"His peculiar merit, according to my own opinion, consists in his method of treating problems of mathematical physics. He has striven with great consistency to purify the mathematical theory from hypothetical assumptions which were not a pure expression of the facts. In this way he has done very much to destroy the old unnatural separation between experimental and mathematical physics, and to reduce the latter to a precise and pure expression of the laws of phenomena. He is an eminent mathematician, but the gift to translate real facts into mathematical equations, and *vice versâ*, is by far more rare than that to find the solution of a given mathematical problem, and in this direction Sir William Thomson is most eminent and original. His electrical instruments and methods of observation, by which he has rendered amongst other things electrostatical phenomena as precisely measureable as magnetic or galvanic forces, give the most striking illustration how much can be gained for practical purposes by a clear insight into theoretical questions; and the series of his papers on thermodynamics and the experimental confirmations of several most surprising theoretical conclusions deduced from Carnot's axiom, point in the same direction."

British science may be congratulated on the fact that in Sir William Thomson the most brilliant genius of the investigator is associated with the most lovable qualities of the man. His single-minded enthusiasm for the promotion of knowledge, his wealth of kindliness for younger men and fellow-workers, and his splendid modesty are among the qualities for which those who know him best admire him most.

METEOROLOGICAL RESEARCH

In previous articles the necessity of dividing into two groups the subjects usually called meteorological has been strongly insisted on. The one of these may be termed climatic meteorology, and is intimately connected with physiology and those sciences which have reference to life. The other may be called physical meteorology, and recent researches have shown that this is intimately connected with other branches of physical inquiry, forming in its wider aspect a sort of meeting ground between molar and molecular physics—a region, in fact, where we find the largest bodies of the universe influencing the smallest.

It is a fortunate thing that we have no longer any need to enlarge upon the practical importance of the latter branch, since this is now recognised even by those who are furthest from considering science worthy of investigation for its own sake; while our present Government, who have shown themselves so willing to further the interests of abstract science, are, we believe, no less anxious to encourage amongst us a truly scientific meteorology. I think, therefore, that the present moment is an opportune one for discussing our subject from the point of view of pure science.

Nor is a feeling of national pride out of place even here. England is the greatest maritime nation on record, and her interests are represented in every quarter of the globe. If her offspring, America, is content to bestow a yearly subsidy of 50,000*l*. on meteorology, it is surely not too much to expect that the subject should receive the most liberal and enlightened treatment from the mother country.

One of the reasons why it is necessary to call attention to meteorology is because the science, being young, is in a very different position from that occupied by her sister sciences, chemistry and physics, so that we cannot be said to have a school of meteorologists at present existing. It would be an object of national importance to encourage the formation of such a school.

Again, while a want of clearness exists generally and everywhere regarding the scope of meteorology, there is also a large amount of widespread ignorance. When a leg of mutton dropped from Nadar's balloon into

the *place* of a French town, the Prefect thought it his duty to report the circumstance along with the state of the barometer and thermometer to his official superiors. Doubtless both dry and wet bulbs were accurately recorded. But I shrewdly suspect there are other nations besides the French who attach inordinate importance to the reading of dry and wet bulbs.

This confusion of mind arises doubtless from the state in which the science has been for more than a century—since the time when the *ignis fatuus* and the fall of an aërolite were grouped together as allied phenomena.

Leaving these times of extreme ignorance—the meteorologically dark ages—we next come to a period when our whole duty to meteorology was considered to be fulfilled by attaching observers of the barometer and thermometer to Royal Societies and Astronomical Institutions. These produced results, which were reduced after a mechanical and strictly statistical method, and then—put aside in a drawer. But we begin to perceive things more clearly now; we see that the duty we owe to the phenomena is to form them into a science, and that the last-mentioned method might have been pursued to the end of the world without leading to anything like a true science of meteorology. To take an extreme case, it would have been just as useful to tabulate the number of leaves that fall in autumn or the number of swallows observable in a day of summer. What then, it may be asked, are we to deal with? We reply that if we are to regard this subject as a science at all, we have here to deal with the action of external bodies upon the earth's envelopes, along with certain reactions of these envelopes upon each other. It will next be asked, How are we to deal with the subject?

In the first place, there ought, of course, to be a well-considered system of observations, which should be internationalised (if we may use the expression) as much as possible, so that each observation should be current coin over the largest possible area.

In the next place there must, of course, be a method of testing the accuracy of the observations. Lastly (and this is a point of the greatest possible importance), the individual observations ought to be thrown open to men of science in general, who should be encouraged and aided to utilise them to the greatest possible extent. Such continuous observations would thus lead to what may be called *sporadic researches*—that is to say, to researches not of the nature of ordinary reductions, and originating with men of science having free access to the observations and generously aided in their inquiries. It is only by this means that the edifice of a true science of meteorology can ever be erected, and then only stone by stone on the foundation of accurate observation.

Taking our present knowledge, let us see what sporadic researches naturally suggest themselves. For this purpose we may divide the subject into three parts—one embracing pure meteorology, another terrestrial magnetism, while a third has reference to the influence of the sun and moon upon terrestrial conditions.

In meteorology we should endeavour to obtain a clear and complete knowledge of the physical motions of the earth's atmosphere and liquid envelope, as well as of the various physical states of aqueous vapour existing in the air. Secondly, we should investigate the cyclical changes of these motions, and inquire into the causes of such changes. Thirdly, we should endeavour to utilise our knowledge, once obtained, in improving our power of predicting weather. In magnetism we should endeavour, by the help of observations already accumulated, to ascertain the causes of the changes which take place in the magnetism of the earth; and also to ascertain what is the nature of the connection between magnetism and meteorology. We should also investigate into the probable cause of the earth's magnetic polarity, and, lastly, ascertain whether a method of predicting meteorological changes may not be furnished by magnetism.

Thirdly and lastly, with respect to solar and lunar researches, we must ascertain the various periods and sub-periods of sun-spot frequency, and of the frequency of solar faculæ and prominences.

We have then to investigate the causes and concomitants of these solar phenomena. It is well known that disturbances of the magnetism and meteorology of the earth are their concomitants. Well—we must try to find out whether such disturbances are caused by the solar outbreaks, or whether both are effects due to some common but unknown cause. Then, with regard to the moon, it will be necessary to investigate fully the nature of her action on meteorology and magnetism, and to ascertain whether this action is independent, or has reference to the position of the sun and to the state of his surface.

It ought here to be mentioned that the above list embraces only those prominent researches that have occurred to the writer of these remarks, and that if observations be thrown open and research encouraged, the dimensions of such a list would be almost indefinitely increased. And I will here repeat that it is only by carrying out such researches as those suggested that we can ever hope to raise meteorology to the rank of a true science.

It is well understood that the carrying out of such researches has formed no essential part of the duties discharged by the existing Meteorological Committee, and that as a matter of fact (with few exceptions) such researches have not been undertaken by them in the past.

Thus, whether or not the importance of such researches was in the minds of those statesmen who subsidised the present system, these inquiries have not yet been carried out, nor do we conceive that they could well be carried out by the existing machinery.

The Committee have, as a preliminary measure, directed their strength, perhaps wisely, to the accumulation of good observations, in other words, to laying the foundation of a future science, rather than to erecting the superstructure.

It remains to be considered whether any change in the present method of administration is absolutely necessary before research can receive due attention. We assume that the present meteorological system of the country is known to our readers: we may briefly state that this system is controlled by a committee consisting of eight unpaid members of the Royal Society, all of whom are eminent in science, although not all eminent in meteorology. This is sufficiently accounted for by reason of our statement, that there is not yet a true school or science of meteorology.

Through the past labours of these men and of their chief officers, the business of the meteorological office has now probably been put into a satisfactory position that will render unnecessary for the future any very great expenditure of energy upon the details of administration.

But such an arrangement, however excellent in a business point of view, must nevertheless necessarily fall short in developing scientific research. For this the undivided attention of several men of science must be secured, and the question we would here wish to submit to the consideration of our readers is the following.

Would not the combination of a few such men devoting their whole time to the subject, together with other men who though well acquainted with the subject, and otherwise qualified, are yet unable to devote their whole time to it, constitute the best possible committee of the future? We need hardly say that the functions of such a board would not be limited to that of producing research within itself. It ought likewise to stimulate and aid outsiders by various means, including advice and perhaps pecuniary aid. It might attach to itself as occasional members the meteorologists of the provinces, inviting their co-operation, giving and receiving advice, and it might even associate with itself as corresponding members, the meteorologists of the colonies and of foreign countries. In fine, the subject is one which perhaps more than any other demands the united action of men of various nations.

From what has just been said, it will readily appear that the sources of information upon which such a committee will draw in their investigations will by no means be confined to those which are under their own immediate control. The stores accumulated by foreign and colonial observers will, of course, be greatly drawn upon, and not only so, but the committee will doubtless also avail themselves of the stores of information possessed by other Governmental departments, as, for instance, those under the control of the hydrographer, who would naturally be a prominent member of the meteorological board, lending them his valuable assistance and co-operation. Besides the hydrographer, it would probably be found necessary to have, at least, three members of the board representing the three divisions of the subject already alluded to, who should be content to devote their whole time to their respective inquiries. The remainder would be composed of distinguished men interested in the subject, but unable to devote their whole time to it, embracing amongst them one or more mathematical physicists of high reputation.

If it be asserted that there are difficulties in the way of such an arrangement, it may be replied that undoubtedly there are; but if the subject were not one of difficulty, the Government would probably not have consulted the Royal Society from the very commencement of their inquiries. Such a powerful engine as a distinguished scientific committee, some of whom are pledged to devote their whole time, and others a portion of it, to the progress of scientific meteorology, is not meant to be used for the mere chopping of straws. The appropriate function of such a committee is surely that of overcoming difficulties.

BALFOUR STEWART

THE "ENCYCLOPÆDIA BRITANNICA."

Encyclopædia Britannica. Vol. IV. (Edinburgh: Adam and Charles Black.)

THE most prominent scientific contribution to the fourth volume of the "Encylopædia Britannica" is Prof. Balfour's article on Botany. In fact, with two other articles, it occupies a fourth of the whole number of pages, and this, together with its very comprehensive title, leads the reader to expect a tolerably complete review of all the various fields of botanical science, an expectation which is confirmed by their enumeration in the opening paragraphs. A little further examination shows, however, that it only treats of a single branch; the "Structure and Morphology of Plants;" "Classification" and "Distribution in Time and Space" are deferred for separate articles, and "Vegetable Physiology" has apparently dropped out of sight altogether. Any division of the matter is, for many reasons, better in an Encyclopædia than to despatch a whole subject *en bloc* with what is substantially a textbook rather than an article. But it is impossible not to regret that the vegetable side of Biology has not had a carefully planned series of contributions by different hands devoted to it like those which from the volumes already published appear to have been arranged for the animal side. And it is at any rate not easy to see why, as it is, one of several contributions should arrogate to itself the general title belonging to the whole. What would be thought of an article headed Zoology which only dealt with the myology of mammals?

The "Encyclopædia Britannica" has become, in its present edition, in a sense a national undertaking. It is so well supported by the best men in different departments of knowledge that it will no doubt come to be regarded as having a kind of representative character. The utterances of the several contributors will be taken as a kind of measure of the state of opinion in this country in each subject. From this point of view it is impossible not to feel that Prof. Balfour's exposition is disappointing as coming from so eminent a teacher, and that the idea it gives of botanical science is unsuggestive to the last degree.

Passing over an historical sketch of which many of the details, such as the last illness of the elder De Candolle, are essentially biographical, we commence with the "Structural Elements of Plants," in other words, their "General Histology." This opens with an account of the cell, which, even in its youngest condition, is stated to contain a sap-cavity; this is by no means the case, and the adjoining illustration, to which reference is made, shows cells with unvacuolated protoplasm, unless the nucleus is made to do duty for a vacuole. On the next page we are told that protoplasm "consists of albuminous substance mixed with water, and some incombustible materials," and that "it also contains some organic compounds;" are we to infer from this that albuminous substance is inorganic? From the cell we pass to the consideration of tissues, which are divided into cellular and vascular. This distinction carries us back half a century to De Candolle's "Organographie Végétale" (1827). Vegetable histologists have, indeed, laboured in vain from

Von Mohl onwards, if they have not succeeded in showing that *all* plant tissues are cellular. Coming to details, it is a little surprising to find (p. 87) sieve tubes (*siebrohren*) confused with dotted ducts (*porengefasse*); the two structures are entirely distinct and are characteristic respectively of the "bast" and "wood" tracts of the fibro-vascular bundle. It is remarked that the "latticed cells of some authors are of a similar nature;" but the real fact is that they are the same thing. Hartig, who discovered the sieve-tubes in *Cucurbita*, found the pores open and occupied by threads of protoplasm which united that of adjoining cells; Von Mohl, doubting this, proposed for them the name of *gitterzellen*, so as to avoid the implication of perforation. Under the head of substances found in cells, we have, of course, an account of starch, sugar, gum, &c. The very important fact that starch grains are always formed in protoplasm, which is also the agent in their eventual solution, is overlooked. Gum, also, is not usually found in cells at all; it is the result of a mucilaginous change of the cell-*walls*.

Next in order would come an account of the principal systems of tissues—epidermal, fundamental, and fibro-vascular. Prof. Balfour treats of the former alone, only recognising a classification of the tissues of the plant into an outer layer bounding an inner mass. This leads him into numerous difficulties. Thus he calls the velamen of the aerial roots of orchids (which is a development of the epidermis), hypoderma, although *that* is a modification of the fundamental *i.e.*, as the name indicates, sub-epidermal tissue. Again, he derives cork from the epidermal layer, whereas it is almost always developed from cortical tissue *under* the epidermis, which is usually destroyed at the time of its production; lenticels, also are connected with cork-formation, and not, as Prof. Balfour states, with the development of aerial roots. It may be noted, also, that the popular theory of the action of stomata still keeps its place here, although long ago shown to be as often as not untrue.

The remainder of the article deals with the morphology of flowering plants with brief and utterly insufficient references to other groups lumped together under the general head of Cryptogams. Prof. Balfour is equally fond of the classification of plants into Dicotyledons, Monocotyledons, and Acotyledons, of which the value at the present time may be estimated by the fact that it was proposed by Jussieu in 1789, and is about as significant now as a classification of religions would be into Unitarians, Christians, and Heathen. Neither here nor elsewhere is there any grasp of general principles to relieve the arid monotony of technicalities often unfortunately inaccurate. A few instances of this may be noted:— The rhizome of Solomon's seal (p. 98) is a typical instance of a definite (*sympodium*), not of an indefinite rhizome (*monopodium*); the stem of the Shola plant is not wholly composed of pith (p. 100), but of a peculiar kind of wood; the dark bands in the transverse section of the tree-fern (Fig. 89) are not woody fibres, they do not belong to the fibro-vascular, but to the fundamental system; on p. 92 we are told that the group of Thallogens comprise Algæ and Fungi, while on p. 107 we find added "and many Hepaticæ"—nothing more being really meant than that they have a thalloid habit; lastly, not to prolong the citations interminably, we are told on p. 119 that "the absorption of carbonic acid water and other fluids is carried on by the leaves, chiefly by the stomata," whereas it is pretty generally believed that the business of leaves is to get rid of water, not to take it in.

One feature of Prof. Balfour's article cannot fail to strike even the most casual reader. This is the extraordinary profusion of technical terms made still more repellent by catching the eye, in italics. Here are some specimens:—

"The names of *bothrenchyma* and *taphrenchyma* have been given to a tissue composed of such cells. Not unfrequently contractions are visible on the outside of the vessel, indicating its formation by coalescence of superposed cells. To vessels exhibiting contractions of this kind, whether spiral or pitted, the terms *moniliform* or *vermiform* have been applied; and the tissue composed of these *moniliform* vessels has been denominated *phleboidal*," p. 87.

"The *parenchyma* of the leaf is the cellular tissue surrounding the vessels, and inclosed within the epidermis. It has sometimes received the names of *diachyma*, *mesophyllum*, and *diploe*," p. 108.

Now it will seem almost incredible to say that all but one of the terms italicised in the passages just quoted are absolutely obsolete. Science is like nature; each stage in the progress of either is furnished with appropriate belongings and surroundings, which pass away for the most part, and give place to new. Literature preserves their remembrance in the one case as the safe keeping of the rocks does in the other. Science has its fossils as geology has, and if we delve after them into the *débris* of the past, it is to learn that the history of either has been continuous, and not to inform ourselves of the actualities of the present. But Prof. Balfour's article is like a breccia to which deposits of every age have sent ill-assorted contributions, and the waifs and strays of to-day have to settle down as best they can with the most ancient and singular remains. No botanist who is engaged in solving actual botanical problems—the existence of which readers of Prof. Balfour's article will hardly suspect—talks about *phleboidal bothrenchyma* or *diploe* any more than he thinks of calling a walnut a *Tryma*, or a grape a *Nuculanium*. Students bent on passing examinations may perhaps persuade themselves, if not their examiners, that in committing such hard words to memory they are making solid additions to their mental furniture. But the real fact is that such things are of no use to anybody, and Mr. Bentham, than whom no living botanist has written more systematic works, has included all the terms - mostly extremely simple —with their definitions which are really needed for the purpose of describing plants, in a short pamphlet of some thirty pages. So that while Prof. Balfour has not succeeded in giving us—what it is the business of an Encyclopædia article to do—a comprehensive view of the broad facts of Vegetable Histology and Morphology in their present aspect, he has certainly not given an account of their terminology which does the subjects justice, but has produced a sort of terminological cemetery in which all kinds of decaying language have been affectionately embalmed.

The unfortunate result of this kind of treatment of the subject—and it is but fair to admit that Prof. Balfour is

by no means the only culprit—is that, even amongst scientific men, botany has come to be regarded in this country as scarcely a serious branch of science at all, and as little more than a kind of biological equivalent of the "Use of the Globes," suitable, indeed, for ladies' schools, and useful, also, like "Materia Medica," for the purpose of occupying the attention of medical students so as to keep them out of mischief during their first summer session.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Visual Phenomena

In support of Mr. Arnulph Mallock's conclusion (vol. xiv. p. 350) as to the cause of the star-shaped appearance presented to the naked eye by a bright point, perhaps the following epitome of some notes which I made last January may have interest:—

1. Looking at a distant lamp, with both eyes, I see a radiant corona round the lamp.

2. I find that this corona is composed of two coronæ superposed, one due to the right eye, the other to the left.

3. Each corona has distinctive features of its own, which are recognised in every observation and have remained the same for years.

4. The radiant beams (which are the conspicuous feature) are not exactly radial, but are forked once or twice.

5. The corona is bounded by a peripheral fringe of blue succeeding to red.

6. The diameter of the corona varies with the diameter of the pupil. The distal portions of the radiant beams are concealed or revealed by the contraction or dilatation of the pupil.

7. Any given part of the radiance may be cut off by advancing an opaque body in front of the eye, from the *same* side as the given part of the radiance.

An obstacle which cuts off only the central rays of the entering pencil only dims the central image, but does not affect the radiance.

The radiance, therefore, is due to the outside rays of the entering pencil becoming excessively refracted so as to be thrown across the visual line before reaching the retina.

8. There is nothing in the *cornea, aqueous humour*, or pupillary margin of the *iris*, that can cause such refraction.

9. It appears most likely that this excessive refraction of the outside rays of the entering pencil is caused by something in the crystalline lens—probably, in the first place, by undue convexity of the more marginal parts of the lens, which are uncovered by dilatation of the pupil.

10. The *radiant* appearance of the corona is probably due to the radiate structure of the crystalline lens.

The agreement between them is pretty close, extending to the furcate character of the rays.

11. On examining my own eyes by a pencil of diverging rays (admitted so as to throw a shadow of anything inside the eye upon the retina) I find that the main beams of the radiance correspond pretty well to the main radii of my lenses, in the opposite direction.

This confirms that the radiance is due to the radiate structure of the lens.

In one particular my observations differ from Mr. Mallock's. He finds that the length of the rays depends "on the brightness of the point" as well as on the size of the pupil. I find that points of different degrees of brightness have rays of the same length, that length being limited only by the size of the pupil, but that the *breadth* of each ray varies with the apparent size of the lamp-flame or other luminous point under observation. Indeed, if the lamp-flame is so bright as to stimulate the iris to contraction, the rays become shortened in like measure.

The radiate structure of the lens of the human eye is well shown in Kolliker's "Manual of Human Microscopic Anatomy" (ed. 1860, p. 568). The "non-fibrillated" or "central planes" there described are possibly of greater refractive power than the wedge-shaped fibrillated portions between them. This would cause the phenomenon of radiance by excessive refraction of the outside rays of the entering pencil. HUBERT AIRY

Edensor, Kidbrook Grove, Blackheath, Aug. 28

Species and Varieties

It may be taken, I presume, that the description and naming of "species" has now a great value as material for studying the laws of the evolution of species and of geographichal distribution and variation; and that the question is not so much to know what name to call a "species" as to account for its presence and form in the economy of nature. And it will, perhaps, also be granted that the study of geographical distribution does not consist alone in acquiring a knowledge of the fauna of a district, so much as in investigating the laws of the special differentiation of that fauna. It thus becomes evident that the slightest modification tending to persistency requires the most careful record, as it is only by the knowledge of first slight modifications that we can expect to understand the process of larger divergencies.

In faunistic catalogues, should the author be inclined to the "lumping method" (perhaps in one sense correctly), a form may be considered as only a variety of some well-known species, and recorded under that name. We thus learn nothing of its modification, and are led to think of it as agreeing with the typical form, thus losing one of the most important facts in our study of variation and distribution. Another element of error seems also co-existent. When a newly-discovered form is designated a variety of another species, it would lead us to suppose that that species is the original type from which the other form has branched. But it is quite possible to suppose on such reasoning that the newly-discovered form may have been the parent from which the previously described species may have been derived. The offspring may have been collected and described before the parent; or we may be filling a space with planets to which there is no sun. This I have frequently suspected in the study of exotic lepidoptera, a study which is principally confined to the perfect form of the insects and of whose larval changes we know in most cases nothing. It rests generally on the judgment of individual entomologists as to the amount of difference to be considered specific.

Without venturing on the vexed question as to species and varieties, would it not be furthering the cause of science that what are considered as merely local varieties should, *as such*, have as careful a description as though they were ranked as species. W. L. DISTANT

Buccleuch Road, West Dulwich.

Antedated Books

I cannot allow that our *Transactions* are antedated, as is asserted by "Another F.Z.S." As is the case with the *Philosophical Transactions* of the Royal Society and the Linnean *Transactions*, no date beyond the year of issue is given on the cover, but there is the additional advantage of the date at which each number goes through the press at the bottom of the sheets. There can, however, I think, be no objection to giving a still more exact date of publication on the cover, and this, in accordance with "Another F.Z.S.'s" suggestion, for which I am much obliged to him, I propose to do in future.

P. L. SCLATER

I am sorry to see that "F.Z.S." still prefers to write under the signature of his first letter. I was in hopes that when he saw the gravity of the accusation which he was bringing against me, he would in his own person have disclaimed any intention of seriously laying such a charge to my door, but as no word of apology escapes him, I regret that in making such an injurious statement he has not added the weight of his name to the accusation. I am, therefore, at liberty to suppose that he is no stranger himself to the "evil practice" (*honi soit qui mal y pense*) which he deprecates, otherwise I cannot imagine such a thought occurring to anyone; but it is evident that on receiving the book his only impulse was to write a letter to this journal instead of charitably endeavouring to discover some feasible explanation of what he calls the "false" date. As most naturalists in England are in the habit of following the rules of the British Association in regard to nomenclature, "F.Z.S." can find more profitable

employment for his pen in proposing such alterations or additions to these rules as would remedy the "grievance" (as I term it) or the "evil practice" (as he prefers to call it), and in that I can assure him he would meet with hearty co-operation from all English naturalists, and from none more heartily than from the undersigned. R. BOWDLER SHARPE

The Origin of Variations

THERE is a slight difference between all three of the answers to Mr. Murphy's queries on Protective Mimicry (vol. xiv. pp. 309, 329); but, I think, the authors of those replies are unanimously over-hasty to call in the aid of protective selection. I cannot but think that the perpetuation of nascent variations may more safely be attributed to causes identical with those in which the variations originate. If this be so, though the origin of variation is necessarily beyond the scope of any selection-theory, these causes continuing to act on the varying organism become of vast importance to the evolutionist. Too much importance cannot, I think, be given in this connection, to the principle of economy of nutrition, or balancement of growth, formulated by Aristotle, in the words "ἅμα δὲ τὴν αὐτὴν ὑπεροχὴν εἰς πολλοὺς τόπους ἀδυνατεῖ διανέμειν ἡ φύσις," and by Goethe, in the expression "Nature, in order to spend on one side, is forced to economise on the other." I gave one example of this law in a previous letter (NATURE, vol. xiii. p. 107) in speaking of the indirect uses of the waste, or secondary products of metastasis in plants; but as the subject is admirably sketched in Mr. Lowne's suggestive essay on "The Philosophy of Evolution," a work too little known or appreciated, I will give here an outline of the argument. Food may be divided into three parts—for nutrition, for the production of energy and waste, or excretion. In many lower organisms the excreted material forms a simple shell; in plants manna, nectar, and resins belong to this group. The chief form of energy in the organic kingdom is that resulting from the oxidation of carbon, chiefly characteristic of animals, while plants secrete the energy-producing material. In higher organisms it is physiologically advantageous that the parts of an organism should differ in the kind of nourishment they require and thus act, as Sir James Paget has shown, as excretory organs to one another. Thus all animals which feed on large quantities of comparatively slightly nutritious matter have a complicated digestive apparatus, and a strong tendency to the production of large skeletons or cutaneous organs, which relieve the special excretory organs. The stag applies a large portion of the calcareous salts derived from the herbage to the production of horns in the male and the bones of the young in the female. The thoracic appendages of the lamellicorns and the beaks of the toucan and hornbill are given as further examples, and "the dermal appendages of reptiles and the feathers of birds, rich in pigment and nitrogen are probably entirely excrementitious to the other tissues." Mr. Lowne makes an interesting final application of this hypothesis to the loss of the hairy covering of the human skin, it being the albuminous tissue most easily dispensed with to nourish the highly developed nervous system. "Phosphorus was likewise required in large quantities and the osseous system became reduced in size." The composition of the nutrient fluid of the organism remaining constant, the excreted matter will be so also, and thus, for example, a rudimentary horn or a pigment may be produced by a change of food and preserved, while the food remains the same, by a physiological selection, as preventing the overtaxing of the kidneys, before sexual selection or protective selection come into play. I have an instance in point before me. Two plants of variegated kale under the influence of the late drought have produced axial structures from the midribs and veins of all their leaves, and I have no doubt that were their seedlings grown under similar nutritive conditions, a race of plants thus substituting fibro-vascular tissue for the usually abnormal development of parenchyma in the kale would be produced. G. S. BOULGER

Agricultural College, Cirencester, Aug. 25

THE BRITISH ASSOCIATION

THE forty-sixth Annual Session of the British Association was formally opened last night by the address of the president, Prof. Andrews, of Belfast. From the reports of the preparations we have already given, it will have been seen that unusual efforts have been made to render this Glasgow meeting a success, and so far as can be judged at present this end has been gained. This is the third time the Association has met in Glasgow. The first occasion was in 1840, when the Marquis of Breadalbane was president, and the last time in 1855, when a similar honour was conferred on the Duke of Argyll. This is the eighth time the Association has held its meeting in Scotland, Edinburgh having been the first northern town visited, so far back as 1834, four years after the foundation of the Association; the Scottish capital was again visited in 1850 and 1871; Aberdeen in 1859, when Prince Albert was president; and Dundee in 1867.

The arrangements for the evening lectures, about which there was at one time some difficulty, have been happily completed. The first lecture will be delivered on Friday in the Kibble Palace, by Prof. Tait; the second, for working-men, in the City Hall, on Saturday evening, probably by Commander Cameron, R.N.; and the third on Monday, Sept. 11, in the Kibble Palace, by Prof. Sir C. Wyville Thomson.

Among the foreign visitors who are expected at the Glasgow meeting, are:—Dr. Janssen, Prof. Negri, of Florence, Prof. Braune, Leipsic, Dr. Edward Grubi, Breslau, Prof. Cohn, Breslau, Prof. Stoletow, Baron von Wrangell, St. Petersburg, and Prof. Ceruti, Rome.

The specially prepared Guide-book to Glasgow is in three volumes, some of the former guides of this description being considered too bulky. The volumes will be full of interesting information regarding such subjects as the geology of the Valley of the Clyde, fossils found in the West of Scotland; the archæology, zoology, and botany of the district; the rise and progress of the iron manufacture in Scotland, chemical industries, the engineering and ship-building industries of the Clyde, and the textile industries of Glasgow and neighbourhood. Mr. Graham, the Hon. Secretary of the Association, has prepared an excellent sketch map of the country surrounding Glasgow, with its general geological features, which has been lithographed, and will be inserted in one of the volumes. Each member of the Association will be presented with a copy of the handbook.

INAUGURAL ADDRESS OF THOMAS ANDREWS, M.D., LL.D., F.R.S., Hon. F.R.S.E., M.R.I.A., &c., PRESIDENT.

SIX and thirty years have passed over since the British Association for the Advancement of Science held its tenth meeting in this ancient city, and twenty-one years have elapsed since it last assembled here. The representatives of two great Scottish families presided on these occasions; and those who had the advantage of hearing the address of the Duke of Argyll in 1855 will recall the gratification they enjoyed while listening to the thoughtful sentiments which reflected a mind of rare cultivation and varied acquirements. On the present occasion I have undertaken, not without anxiety, the duty of filling an office at first accepted by one whom Scotland and the Association would alike have rejoiced to see in this Chair, not only as a tribute to his own scientific services, but also as recognising in him the worthy representative of that long line of able men who have upheld the pre-eminent position attained by the Scottish schools of medicine in the middle of the last century, when the mantle of Boerhaave fell upon Monro and Cullen.

The task of addressing this Association, always a difficult one, is not rendered easier when the meeting is held in a place which presents the rare combination of being at once an ancient seat of learning and a great centre of modern industry. Time will not permit me to refer to the distinguished men who in early days have left here their mark behind them; and I regret it the more, as there is a growing tendency to exaggerate the value of later discoveries, and to underrate the achievements of those who have lived before us. Confining our attention to a period reaching back to little more than a century, it appears that during that time three new sciences arose, at least as far as any science can be said to have a distinct origin, in this city of Glasgow—Experimental Chemistry, Political Economy, and Mechanical Engineering. It is now conceded that Black laid the foundation of modern chemistry; and no one has ever disputed the claims of Adam Smith and of Watt to have not only founded, but largely

built up the two great branches of knowledge with which their names will always be inseparably connected. It was here that Dr. Thomas Thomson established the first school of Practical Chemistry in Great Britain, and that Sir W. Hooker gave to the chair of Botany a European celebrity; it was here that Graham discovered the law of gaseous diffusion and the properties of polybasic acids; it was here that Stenhouse and Anderson, Rankine and J. Thomson made some of their finest discoveries; and it was here that Sir William Thomson conducted his physico-mathematical investigations, and invented those exquisite instruments, valuable alike for ocean telegraphy and for scientific use, which are among the finest trophies of recent science. Nor must the names of Tennant, Mackintosh, Neilson, Walter Crum, Young, and Napier be omitted, who, with many others in this place, have made large and valuable additions to practical science.

The safe return of the *Challenger*, after an absence of three and a half years, is a subject of general congratulation. Our knowledge of the varied forms of animal life, and of the remains of animal life, which occur, it is now known, over large tracts of the bed of the ocean, is chiefly derived from the observations made in the *Challenger* and in the previous deep-sea expeditions which were organised by Sir Wyville Thomson and Dr. Carpenter. The physical observations, and especially those on the temperature of the ocean, which were systematically conducted throughout the whole voyage of the *Challenger*, have already supplied valuable data for the resolution of the great question of ocean-currents. Upon this question, which has been discussed with singular ability, but under different aspects, by Dr. Carpenter and Mr. Croll, I cannot attempt here to enter; nor will I venture to forestall, by any crude analysis of my own, the narrative which Sir W. Thomson has kindly undertaken to give of his own achievements and of those of his staff during their long scientific cruise.

Another expedition, which has more than fulfilled the expectations of the public, is Lieut. Cameron's remarkable journey across the continent of Africa. It is by such enterprises, happily conceived and ably executed, that we may hope at no distant day to see the Arab slave-dealer replaced by the legitimate trader, and the depressed populations of Africa gradually brought within the pale of civilised life.

From the North Polar Expedition no intelligence has been received; nor can we expect for some time to hear whether it has succeeded in the crowning object of Arctic enterprise. In the opinion of many, the results, scientific or other, to be gained by a full survey of the Arctic regions can never be of such value as to justify the risk and cost which must be incurred. But it is not by cold calculations of this kind that great discoveries are made or great enterprises achieved. There is an inward and irrepressible impulse—in individuals called a spirit of adventure, in nations a spirit of enterprise—which impels mankind forward to explore every part of the world we inhabit, however inhospitable or difficult of access; and if the country claiming the foremost place among maritime nations shrink from an undertaking because it is perilous, other countries will not be slow to seize the post of honour. If it be possible for man to reach the poles of the earth, whether north or south, the feat must sooner or later be accomplished; and the country of the successful adventurers will be thereby raised in the scale of nations.

The passage of Venus over the sun's disc is an event which cannot be passed over without notice, although many of the circumstances connected with it have already become historical. It was to observe this rare astronomical phenomenon, on the occasion of its former occurrence in 1769, that Capt. Cook's memorable voyage to the Pacific was undertaken, in the course of which he explored the coast of New South Wales, and added that great country to the possessions of the British Crown.

As the transit of Venus gives the most exact method of calculating the distance of the earth from the sun, extensive preparations were made on the last occasion for observing it at selected stations—from Siberia in northern, to Kerguelen's Land in southern latitudes. The great maritime powers vied with each other to turn the opportunity to the best account; and Lord Lindsay had the spirit to equip, at his own expense, the most complete expedition which left the shores of this country. Some of the most valuable stations in southern latitudes were desert islands, rarely free from mist or tempest, and without harbours or shelter of any kind. The landing of the instruments was in many cases attended with great difficulty and even personal risk. Photography lent its aid to record automatically the progress of the transit; and M. Janssen contrived a revolving plate, by means of which from fifty to sixty images of the edge of the sun could be taken at short intervals during the critical periods of the phenomenon.

The observations of M. Janssen at Nagasaki, in Japan, were of special interest. Looking through a violet-blue glass he saw Venus, two or three minutes before the transit began, having the appearance of a pale round spot near the edge of the sun. Immediately after contact the segment of the planet's disc, as seen on the face of the sun, formed with what remained of this spot a complete circle. The pale spot when first seen was, in short, a partial eclipse of the solar corona, which was thus proved beyond dispute to be a luminous atmosphere surrounding the sun. Indications were at the same time obtained of the existence of an atmosphere around Venus.

The mean distance of the earth from the sun was long supposed to have been fixed within a very small limit of error at about 95,000,000 miles. The accuracy of this number had already been called in question on theoretical grounds by Hansen and Leverrier, when Foucault, in 1862, decided the question by an experiment of extraordinary delicacy. Taking advantage of the revolving-mirror, with which Wheatstone had some time before enriched the physical sciences, Foucault succeeded in measuring the absolute velocity of light in space by experiments on a beam of light, reflected backwards and forwards, within a tube little more than thirteen feet in length. Combining the result thus obtained with what is called by astronomers the constant of aberration, Foucault calculated the distance of the earth from the sun, and found it to be one-thirtieth part, or about 3,000 000 miles, less than the commonly received number. This conclusion has lately been confirmed by M. Cornu, from a new determination he has made of the velocity of light according to the method of Fizeau; and in complete accordance with these results are the investigations of Leverrier, founded on a comparison with theory of the observed motions of the sun and of the planets Venus and Mars. It remains to be seen whether the recent observations of the transit of Venus, when reduced, will be sufficiently concordant to fix with even greater precision the true distance of the earth from the sun.

In this brief reference to one of the finest results of modern science, I have mentioned a great name whose loss England has recently had to deplore, and in connection with it the name of an illustrious physicist whose premature death deprived France, a few years ago, of one of her brightest ornaments—Wheatstone and Foucault, ever to be remembered for their marvellous power of eliciting, like Galileo and Newton, from familiar phenomena the highest truths of nature!

The discovery of Huggins that some of the fixed stars are moving towards and others receding from our system, has been fully confirmed by a careful series of observations lately made by Mr. Christie in the Observatory of Greenwich. Mr. Huggins has not been able to discover any indications of a proper motion in the nebulæ; but this may arise from the motion of translation being less than the method would discover. Few achievements in the history of science are more wonderful than the measurement of the proper motions of the fixed stars, from observing the relative position of two delicate lines of light in the field of the telescope.

The observation of the American astronomer Young, that bright lines, corresponding to the ordinary lines of Fraunhofer reversed, may be seen in the lower strata of the solar atmosphere for a few moments during a total eclipse, has been confirmed by Mr. Stone, on the occasion of the total eclipse of the sun which occurred some time ago in South Africa. In the outer corona, or higher regions of the sun's atmosphere, a single green line only was seen, the same which had been already described by Young.

I can here refer only in general terms to the observations of Roscoe and Schuster on the absorption-bands of potassium and sodium, and to the investigations of Lockyer on the absorptive powers of metallic and metalloidal vapours at different temperatures. From the vapour of calcium the latter has obtained two wholly distinct spectra, one belonging to a low, and the other to a high, temperature. Mr. Lockyer is also engaged on a new and greatly extended map of the solar spectrum.

Spectrum analysis has lately led to the discovery of a new metal—gallium—the fifth whose presence has been first indicated by that powerful agent. This discovery is due to M. Lecoq de Boisbaudran, already favourably known by a work on the application of the spectroscope to chemical analysis.

Our knowledge of aerolites has of late years been greatly increased; and I cannot occupy a few moments of your time more usefully than by briefly referring to the subject. So recently as 1860 the most remarkable meteoric fall on record, not even excepting that of L'Aigle, occurred near the village of New Concord in Ohio. On a day when no thunder-clouds were visible, loud sounds were heard resembling claps of thunder, followed by a large fall of meteoric stones, some of which were distinctly seen to strike the earth. One stone, above 50 pounds in weight, buried itself to the depth of 2 feet in the ground, and when dug out was found to be still warm. In 1872 another remarkable meteorite, at first seen as a brilliant star with a luminous train, burst near Orvinio in Italy, and six fragments of it were afterwards collected.

Isolated masses of metallic iron, or rather of an alloy of iron and nickel, similar in composition and properties to the iron usually diffused in meteoric stones, have been found here and there on the surface of the earth, some of large size, as one described by Pallas, which weighed about two-thirds of a ton. Of the meteoric origin of these masses of iron there is little room for doubt, although no record exists of their fall. Sir Edward Sabine, whose life has been devoted with rare fidelity to the pursuit of science, and to whose untiring efforts this Association largely owes the position it now occupies, was the pioneer of the newer discoveries in meteoric science. Eight and fifty years ago he visited, with Capt. Ross, the northern shores of Baffin's Bay, and made the interesting discovery that the knife-blades used by the Esquimaux in the vicinity of the Arctic highlands were formed of meteoric iron. This observation was afterwards fully confirmed; and scattered blocks of meteoric iron have been found from time to time around Baffin's Bay. But it was not till 1870 that the meteoric treasures of Baffin's Bay were truly discovered. In that year Nordenskiold found, at a part of the shore difficult of approach even in moderate weather, enormous blocks of meteoric iron, the largest weighing nearly twenty tons, imbedded in a ridge of basaltic rock. The interest of this observation is greatly enhanced by the circumstance that these masses of meteoric iron, like the basalt with which they are associated, do not belong to the present geological epoch, but must have fallen long before the actual arrangement of land and sea existed—during, in short, the middle Tertiary, or Miocene period of Lyell. The meteoric origin of these iron masses from Ovifak has been called in question by Lawrence Smith; and it is no doubt possible that they may have been raised by upheaval from the interior of the earth. I have, indeed, myself shown by a magneto-chemical process, that metallic iron, in particles so fine that they have never yet been actually seen, is everywhere diffused through the Miocene basalt of Slieve Mish, in Antrim, and may likewise be discovered by careful search in almost all igneous and in many metamorphic rocks. These observations have since been verified by Reuss in the case of the Bohemian basalts. But, as regards the native iron of Ovifak, the weight of evidence appears to be in favour of the conclusion, at which M. Daubrée, after a careful discussion of the subject, has arrived—that it is really of meteoric origin. This Ovifak iron is also remarkable from containing a considerable amount of carbon partly combined with the iron, partly diffused through the metallic mass in a form resembling coke. In connection with this subject, I must refer to the able and exhaustive memoirs of Maskelyne on the Busti and other aerolites, to the discovery of vanadium by R. Apjohn in a meteoric iron, to the interesting observations of Sorby, and to the researches of Daubrée, Wohler, Lawrence Smith, Tschermak, and others.

The important services which the Kew Observatory has rendered to meteorology and to solar physics have been fully recognised; and Mr. Gassiot has had the gratification of witnessing the final success of his long and noble efforts to place this observatory upon a permanent footing. A physical observatory for somewhat similar objects, but on a larger scale, is in course of erection, under the guidance of M. Janssen, at Fontenay, in France, and others are springing up or already exist in Germany and Italy. It is earnestly to be hoped that this country will not lag behind in providing physical observatories on a scale worthy of the nation and commensurate with the importance of the object. On this question I cannot do better than refer to the high authority of Dr. Balfour Stewart, and to the views he expressed in his able address last year to the Physical Section.

Weather telegraphy, or the reporting by telegraph the state of the weather at selected stations to a central office, so that notice of the probable approach of storms may be given to the seaports, has become in this country an organised system; and considering the little progress meteorology has made as a science, the results may be considered to be on the whole satisfactory. Of the warnings issued of late years, four out of five were justified by the occurrence of gales or strong winds. Few storms occurred for which no warnings had been given; but unfortunately among these were some of the heaviest gales of the period. The stations from which daily reports are sent to the meteorological office in London embrace the whole coast of Western Europe, including the Shetland Isles. It appears that atmospheric disturbances seldom cross the Atlantic without being greatly altered in character, and that the origin of most of our storms lies eastward of the longitude of Newfoundland.

As regards the velocity of the wind, the cup-anemometer of Dr. Robinson has fully realised the expectations of its discoverer; and the venerable astronomer of Armagh has been engaged during the past summer, with all the ardour of youth, in a course of laborious experiments to determine the constants of his instrument. From seven years' observations at the Observatory of Armagh, he has found that the mean velocity of the wind is greatest in the S.S.W. octant, and least in the opposite one, and that the amount of wind attains a maximum in January, after which it steadily decreases, with one slight exception, till July, augmenting again till the end of the year.

Passing to the subject of electricity, it is with pleasure that I have to announce the failure of a recent attempt to deprive Oerstedt of his great discovery. It is gratifying thus to find high reputations vindicated, and names which all men love to honour transmitted with undiminished lustre to posterity. At a former meeting of this Association, remarkable for an unusual attendance of distinguished foreigners, the central figure was Oerstedt. On that occasion Sir John Herschel in glowing language compared Oerstedt's discovery to the blessed dew of heaven which only the mastermind could draw down, but which it was for others to turn to account and use for the fertilisation of the earth. To Franklin, Volta, Coulomb, Oerstedt, Ampère, Faraday, Seebeck, and Ohm are due the fundamental discoveries of modern electricity—a science whose applications in Davy's hands led to grander results than alchemist ever dreamed of, and in the hands of others (among whom Wheatstone, Morse, and Thomson occupy the foremost place) to the marvels of the electric telegraph. When we proceed from the actual phenomena of electricity to the molecular conditions upon which those phenomena depend, we are confronted with questions as recondite as any with which the physicist has had to deal, but towards the solution of which the researches of Faraday have contributed the most precious material. The theory of electrical and magnetic action occupied formerly the powerful minds of Poisson, Green, and Gauss; and among the living it will surely not be invidious to cite the names of Weber, Helmholtz, Thomson, and Clerk Maxwell. The work of the latter on electricity is an original essay worthy in every way of the great reputation and of the clear and far-seeing intellect of its author.

Among recent investigations I must refer to Prof. Tait's discovery of consecutive neutral points in certain thermo-electric junctions, for which he was lately awarded the Keith prize. This discovery has been the result of an elaborate investigation of the properties of thermo-electric currents, and is specially interesting in reference to the theory of dynamical electricity. Nor can I omit to mention the very interesting and original experiments of Dr. Kerr on the dielectric state, from which it appears that when electricity of high tension is passed through dielectrics, a change of molecular arrangement occurs, slowly in the case of solids, quickly in the case of liquids, and that the lines of electric force are in some cases lines of compression, in other cases lines of extension.

Of the many discoveries in physical science due to Sir William Grove, the earliest and not the least important is the battery which bears his name, and is to this day the most powerful of all voltaic arrangements; but with a Grove's battery of 50 or even 100 cells in vigorous action, the spark will not pass through any appreciable distance of cold air. By using a very large number of cells, carefully insulated and charged with water, Mr. Gassiot succeeded in obtaining a short spark through air; and lately De La Rue and Muller have constructed a large chloride of silver battery giving freely sparks through cold air, which, when a column of pure water is interposed in the circuit, accurately resemble those of the common electrical machine. The length of the spark increasing nearly as the square of the number of cells, it has been calculated that with 100,000 elements of this battery the discharge should take place through a distance of no less than eight feet in air.

In the solar beam we have an agent of surpassing power, the investigation of whose properties by Newton forms an epoch in the history of experimental science scarcely less important than the discovery of the law of gravitation in the history of physical astronomy. Three actions characterise the solar beam, or, indeed, more or less that of any luminous body—the heating, the physiological, and the chemical. In the ordinary solar beam we can modify the relative amount of these actions by passing it through different media, and we can thus have luminous rays with little heating or little chemical action. In the case of the moon's rays it required the highest skill on the part of Lord Rosse, even with all the resources of the observatory of Parsonstown, to investigate their heating properties, and to show that the surface of our satellite facing the earth passes, during every lunation, through a greater range of temperature than the difference between the freezing- and boiling-points of water.

But if, instead of taking an ordinary ray of light, we analyse it as Newton did by the prism, and isolate a very fine line of the spectrum (theoretically a line of infinite tenuity), that is to say, if we take a ray of definite refrangibility, it will be found impossible, by screens or otherwise, to alter its properties. It was his clear perception of the truth of this principle that led Stokes to his great discovery of the cause of epipolic dispersion, in which he showed that many bodies had the power of absorbing dark rays of high refrangibility and of emitting them as luminous rays of lower refrangibility—of absorbing, in short, darkness and of emitting it as light. It is not, indeed, an easy matter in all cases to say whether a given effect is due to the action of heat or light; and the question which of these forces is the efficient agent in causing the motion of the tiny discs in Crookes's radiometer has given rise to a good deal of discussion. The answer to this question involves the same principles as those by which the image traced on the daguerreotype plate, or the decomposition of carbonic acid by the leaves of plants, is referred to the action of light and not of heat; and applying these principles to the experiments made with the radiometer, the weight of evidence appears to be in favour of the view that the repulsion of the blackened surfaces of the discs is due to a thermal reaction occurring in a highly rarefied medium. I have myself had the pleasure of witnessing many of Mr. Crookes's experiments, and I cannot sufficiently express my admiration of the care and skill with which he has pursued this investigation. The remarkable repulsions he has observed in the most perfect vacua hitherto attained are interesting, not only as having led to the construction of a beautiful instrument, but as being likely, when the subject is fully investigated, to give valuable data for the theory of molecular actions.

A singular property of light, discovered a short time ago by Mr. Willoughby Smith, is its power of diminishing the electrical resistance of the element selenium. This property has been ascertained to belong chiefly to the luminous rays on the red side of the spectrum, being nearly absent in the violet or more refrangible rays and also in heat-rays of low refrangibility. The recent experiments of Prof. W. G. Adams have fully established the accuracy of the remarkable observation, first made by Lord Rosse, that the action appeared to vary inversely as the simple distance of the illuminating source.

Switzerland sent, some years ago, as its representative to this country, the celebrated De la Rive, whose scientific life formed lately the subject of an eloquent *éloge* from the pen of M. Dumas. On this occasion we have to welcome, in General Menabrea, a distinguished representative both of the kingdom of Italy and of Italian science. His great work on the determination of the pressures and tensions in an elastic system is of too abstruse a character to be discussed in this address; but the principle it contains may be briefly stated in the following words:—"When any elastic system places itself in equilibrium under the action of external forces, the work developed by the internal forces is a minimum." General Menabrea has, however, other and special claims upon us here, as the friend to whom Babbage entrusted the [illegible] ana[illegible] which [illegible] later life. The latest development of this conception is to be found in the mechanical integrator of Prof. J. Thomson, in which motion is transmitted, according to a new kinematic principle, from a disk or cone to a cylinder through the intervention of a loose ball, and in Sir W. Thomson's machine for the mechanical integration of differential equations of the second order. In the exquisite tidal machine of the latter we have an instrument by means of which the height of the tide at a given port can be accurately predicted for all times of the day and night.

The attraction-meter of Siemens is an instrument of great delicacy for measuring horizontal attractions, which it is proposed to use for recording the attractive influences of the sun and moon, upon which the tides depend. The bathometer of the same able physicist is another remarkable instrument, in which the constant force of a spring is opposed to the variable pressure of a column of mercury. By an easy observation of the bathometer on shipboard, the depth of the sea may be approximately ascertained without the use of a sounding-line.

The Loan Exhibition of Apparatus at Kensington has been a complete success, and cannot fail to be useful both in extending a knowledge of scientific subjects and in promoting scientific research throughout the country. Unique in character, but most interesting and instructive, this exhibition will, it is to be hoped, be the precursor of a permanent museum of scientific objects, which, like the present exhibition, shall be a record of old as well as a representation of new inventions.

It is often difficult to draw a distinct line of separation between the physical and chemical sciences; and it is perhaps doubtful whether the division is not really an artificial one. The chemist cannot, indeed, make any large advance without having to deal with physical principles; and it is to Boyle, Dalton, Gay-Lussac, and Graham that we owe the discovery of the mechanical laws which govern the properties of gases and vapours. Some of these laws have of late been made the subject of searching inquiry, which has fully confirmed their accuracy, when the body under examination approaches to what has not inaptly been designated the ideal gaseous state. But when gases are examined under varied conditions of pressure and temperature, it is found that these laws are only particular cases of more general laws, and that the laws of the gaseous state, as it exists in nature, although they may be enunciated in a precise and definite form, are very different from the simple expressions which apply to the ideal condition. The new laws become in their turn inapplicable when from the gaseous state proper we pass to those intermediate conditions which, it has been shown, link with unbroken continuity the gaseous and liquid states. As we approach the liquid state, or even when we reach it, the problem becomes more complicated; but its solution even in these cases will, it may confidently be expected, yield to the powerful means of investigation we now possess.

Among the more important researches made of late in physical chemistry, I may mention those of F. Weber on the specific heat of carbon and the allied elements, of Berthelot on thermo-chemistry, of Bunsen on spectrum analysis, of Wullner on the band- and line-spectra of the gases, and of Guthrie on the chryohydrates.

Cosmical chemistry is a science of yesterday; and yet it already abounds in facts of the highest interest. Hydrogen, which, if the absolute zero of the physicist does not bar the way, we may hope yet to see in the metallic form, appears to be everywhere present in the universe. It exists in enormous quantity in the solar atmosphere, and it has been discovered in the atmospheres of the fixed stars. It is present, and is the only known element of whose presence we are certain, in those vast sheets of ignited gas of which the nebulæ proper are composed. Nitrogen is also widely diffused among the stellar bodies, and carbon has been discovered in more than one of the comets. On the other hand, a prominent line in the spectrum of the Aurora Borealis has not been identified with that of any known element; and the question may be asked:—Does a new element, in a highly rarefied state, exist in the upper regions of our atmosphere? or are we, with Angstrom, to attribute this line to a fluorescent or phosphorescent light produced by the electrical discharge to which the aurora is due? This question awaits further observations before it can be definitely settled, as does also that of the source of the remarkable green line which is everywhere conspicuous in the solar corona.

I must here pause for a moment to pay a passing tribute to the memory of Angstrom, whose great work on the solar spectrum will always remain as one of the finest monuments of the science of our period. The influence, indeed, which the labours of Angstrom and of Kirchhoff have exerted on the most interesting portion of later physics can scarcely be exaggerated; and it may be truly said that there are few men whose loss will be longer felt or more deeply deplored than that of the illustrious astronomer of Upsala.

I cannot pursue this subject further, nor refer to the other terrestrial elements which are present in the solar and stellar

atmospheres. Among the many elements that make up the ordinary aerolite, not one has been discovered which does not occur upon this earth. On the whole, we arrive at the grand conclusion that this mighty universe is chiefly built up of the same materials as the globe we inhabit.

In the application of science to the useful purposes of life, chemistry and mechanics have run an honourable race. It was in the valley of the Clyde that the chief industry of this country received, within the memory of many here present, an extraordinary impulse from the application by Neilson of the hot blast to the smelting of iron. The Bessemer steel process and the regenerative furnace of Siemens are later applications of high scientific principles to the same industry. But there is ample work yet to be done. The fuel consumed in the manufacture of iron—as, indeed, in every furnace where coal is used—is greatly in excess of what theory indicates; and the clouds of smoke which darken the atmosphere of our manufacturing towns, and even of whole districts of country, are a clear indication of the waste, but only of a small portion of the waste, arising from imperfect combustion. The depressing effect of this atmosphere upon the working population can scarcely be overrated. Their pale—I had almost said etiolated—faces are a sure indication of the absence of the vivifying influence of the solar rays, so essential to the maintenance of vigorous health. The chemist can furnish a simple test of this state of the atmosphere in the absence of ozone—the active form of oxygen—from the air of our large towns. At some future day the efforts of science to isolate, by a cheap and available process, the oxygen of the air for industrial purposes may be rewarded with success. The effect of such a discovery would be to reduce the consumption of fuel to a fractional part of its present amount; and although the carbonic acid would remain, the smoke and carbonic oxide would disappear. But an abundant supply of pure oxygen is not now within our reach; and in the meantime may I venture to suggest that in many localities the waste products of the furnace might be carried off to a distance from the busy human hive by a few horizontal flues of large dimensions, terminating in lofty chimneys on a hill side or distant plain? A system of this kind has long been employed at the mercurial mines of Idria, and in other smelting-works where noxious vapours are disengaged. With a little care in the arrangements the smoke would be wholly deposited, as flue dust or soot, in the horizontal galleries, and would be available for the use of the agriculturist.

The future historian of organic chemistry will have to record a succession of beneficent triumphs, in which the efforts of science have led to results of the highest value to the well-being of man. The discovery of quinine has probably saved more human life, with the exception of that of vaccination, than any discovery of any age; and he who succeeds in devising an artificial method of preparing it will be truly a benefactor of the race. Not the least valuable, as it has been one of the most successful, of the works of our Government in India has been the planting of the cinchona-tree on the slopes of the Himalaya. As artificial methods are discovered, one by one, of preparing the proximate principles of the useful dyes, a temporary derangement of industry occurs, but in the end the waste materials of our manufactures set free large portions of the soil for the production of human food.

The ravages of insects have ever been the terror of the agriculturist, and the injury they inflict is often incalculable. An enemy of this class, carried over from America, threatened lately with ruin some of the finest vine districts in the south of France. The occasion has called forth a chemist of high renown; and in a classical memoir recently published, M. Dumas appears to have resolved the difficult problem. His method, although immediately applied to the *Phylloxera* of the vine, is a general one, and will no doubt be found serviceable in other cases. In the apterous state the *Phylloxera* attacks the roots of the plant; and the most efficacious method hitherto known of destroying it has been to inundate the vineyard. After a long and patient investigation, M. Dumas has discovered that the sulphocarbonate of potassium, in dilute solution, fulfils every condition required from an insecticide, destroying the insect without injuring the plant. The process requires time and patience; but the trials in the vineyard have fully confirmed the experiments of the laboratory.

The application of artificial cold to practical purposes is rapidly extending; and, with the improvement of the ice machine, the influence of this agent upon our supply of animal food from distant countries will undoubtedly be immense. The ice machine is already employed in paraffin-works and in large breweries; and the curing or salting of meat is now largely conducted in vast chambers, maintained throughout the summer at a constant temperature by a thick covering of ice.

I have now completed this brief review, rendered difficult by the abundance, not by the lack of materials. Even confining our attention to the few branches of science upon which I have ventured to touch, and omitting altogether the whole range of pure chemistry, it is with regret that I find myself constrained to make only a simple reference to the important work of Cayley on the Mathematical Theory of Isomers, and to elaborate memoirs which have recently appeared in Germany on the reflection of heat- and light-rays, and on the specific heat and conducting-power of gases for heat, by Knoblauch, E. Wiedemann, Winkelmann, and Buff.

The decline of science in England formed the theme, fifty years ago, of an elaborate essay by Babbage; but the brilliant discoveries of Faraday soon after wiped off the reproach. I will not venture to say the alarm which has lately arisen, here and elsewhere, on the same subject will prove to be equally groundless. The duration of every great outburst of human activity, whether in art, in literature, or in science, has always been short, and experimental science has made gigantic advances during the last three centuries. The evidence of any great failure is not, however, very manifest, at least in the physical sciences. The journal of Poggendorff, which has long been a faithful record of the progress of physical research throughout the world, shows no sign of flagging; and the Jubelband by which Germany celebrated the fiftieth year of Poggendorff's invaluable services was at the same time an ovation to a scientific veteran who has perhaps done more than any man living to encourage the highest forms of research, and a proof that in Northern Europe the physical sciences continue to be ably and actively cultivated. If in chemistry the case is somewhat weaker, the explanation, at least in this country, is chiefly to be found in the demand on the part of the public for professional aid from many of our ablest chemists.

But whatever view be taken of the actual condition of scientific research, there can be no doubt that it is both the duty and the interest of the country to encourage a pursuit so ennobling in itself, and fraught with such important consequences to the well-being of the community. Nor is there any question in which this Association, whose special aim is the advancement of science, can take a deeper interest. The public mind has also been awakened to its importance, and is prepared to aid in carrying out any proposal which offers a reasonable prospect of advantage.

In its recent phase the question of scientific research has been mixed up with contemplated changes in the great Universities of England, and particularly in the University of Oxford. The national interests involved on all sides are immense, and a false step once taken may be irretrievable. It is with diffidence that I now refer to the subject, even after having given to it the most anxious and careful consideration.

As regards the higher mathematics, their cultivation has hitherto been chiefly confined to the Universities of Cambridge and Dublin, and two great mathematical schools will probably be sufficient for the kingdom. The case of the physical and natural sciences is different, and they ought to be cultivated in the largest and widest sense at every complete university. Nor, in applying this remark to the English Universities, must we forget that if Cambridge was the *alma mater* of Newton and Cavendish, Oxford gave birth to the Royal Society. The ancient renown of Oxford will surely not suffer, while her material position cannot fail to be strengthened, by the expansion of scientific studies and the encouragement of scientific research within her walls. Nor ought such a proposal to be regarded as in any way hostile to the literary studies, and especially to the ancient classical studies, which have always been so carefully cherished at Oxford. If, indeed, there were any such risk, few would hesitate to exclaim —let science shift elsewhere for herself, and let literature and philosophy find shelter in Oxford! But there is no ground for any such anxiety. Literature and science, philosophy and art, when properly cultivated, far from opposing, will mutually aid one another. There will be ample room for all, and by judicious arrangements all may receive the attention they deserve.

A University, or Studium Generale, ought to embrace in its arrangements the whole circle of studies which involve the material interests of society, as well as those which cultivate intellectual refinement. The industries of the country should look to the universities for the development of the principles of applied as well as of abstract science; and in this respect no institutions have ever had so grand a possession within easy

reach as have the universities of England at this conjuncture, if only they have the courage to seize it. With their historic reputation, their collegiate endowments, their commanding influence, Oxford and Cambridge should continue to be all that they now are; but they should, moreover, attract to their lecture-halls and working cabinets students in large numbers preparing for the higher industrial pursuits of the country. The great physical laboratory in Cambridge, founded and equipped by the noble representative of the House of Cavendish, has in this respect a peculiar significance, and is an important step in the direction I have indicated. But a small number only of those for whom this temple of science is designed are now to be found in Cambridge. It remains for the University to perform its part, and to widen its portals so that the nation at large may reap the advantage of this well-timed foundation.

If the Universities, in accordance with the spirit of their statutes, or at least of ancient usage, would demand from the candidates for some of the higher degrees proof of original powers of investigation, they would give an important stimulus to the cultivation of science. The example of many continental universities, and among others of the venerable University of Leyden, may here be mentioned. Two proof essays recently written for the degree of Doctor of Science in Leyden, one by Van der Waals, the other by Lorenz, are works of unusual merit; and another pupil of Professor Rijke is now engaged in an elaborate experimental research as a qualification for the same degree.

The endowment of a body of scientific men devoted exclusively to original research, without the duty of teaching or other occupation, has of late been strongly advocated in this country; and M. Fremy has given the weight of his high authority to a somewhat similar proposal for the encouragement of research in France. I will not attempt to discuss the subject as a national question, the more so as after having given the proposal the most careful consideration in my power, and turned it round on every side, I have failed to discover how it could be worked so as to secure the end in view.

But whatever may be said in favour of the endowment of pure research as a national question, the Universities ought surely never to be asked to give their aid to a measure which would separate the higher intellects of the country from the flower of its youth. It is only through the influence of original minds that any great or enduring impression can be produced on the hopeful student. Without original power, and the habit of exercising it, you may have an able instructor, but you cannot have a great teacher. No man can be expected to train others in habits of observation and thought he has never acquired himself. In every age of the world the great schools of learning have, as in Athens of old, gathered around great and original minds, and never more conspicuously than in the modern schools of chemistry, which reflected the genius of Liebig, Wohler, Bunsen, and Hofmann. These schools have been nurseries of original research as well as models of scientific teaching: and students attracted to them from all countries became enthusiastically devoted to science, while they learned its methods from example even more than from precept. Will any one have the courage to assert that organic chemistry, with its many applications to the uses of mankind, would have made in a few short years the marvellous strides it has done, if Science, now as in mediæval times, had pursued her work in strict seclusion,

> Semota ab nostris rebus, seiunctaque longe
> Ipsa suis pollens opibus, nil indiga nostri?

But while the Universities ought not to apply their resources in support of a measure which would render their teaching ineffective, and would at the same time dry up the springs of intellectual growth, they ought to admit freely to university positions men of high repute from other universities, and even without academic qualifications. An honorary degree does not necessarily imply a university education; but if it have any meaning at all, it implies that he who has obtained it is at least on a level with the ordinary graduate, and should be eligible to university positions of the highest trust.

Not less important would it be for the encouragement of learning throughout the country that the English Universities, remembering that they were founded for the same objects, and derive their authority from a common source, should be prepared to recognise the ancient Universities of Scotland as freely as they have always recognised the Elizabethan University of Dublin. Such a measure would invigorate the whole university system of the country more than any other I can think of. It would lead to the strengthening of the literary element in the northern, and of the practical element in the southern Universities, and it would bring the highest teaching of the country everywhere more fully into harmony with the requirements of the times in which we live. As an indirect result, it could not fail to give a powerful impulse to literary pursuits as well as to scientific investigations. Professors would be promoted from smaller positions in one university to higher positions in another, after they had given proofs of industry and ability; and stagnation, hurtful alike to professorial and professional life, would be effectually prevented. If this union were established among the old Universities, and if at the same time a new University (as I myself ten years ago earnestly proposed) were founded on sound principles amidst the great populations of Lancashire and Yorkshire, the university system of the country would gradually receive a large and useful extension, and, without losing any of its present valuable characteristics, would become more intimately related than hitherto with those great industries upon which mainly depend the strength and wealth of the nation.

It may perhaps appear to many a paradoxical assertion to maintain that the industries of the country should look to the calm and serene regions of Oxford and Cambridge for help in the troublous times of which we have now a sharp and severe note of warning. But I have not spoken on light grounds, nor without due consideration. If Great Britain is to retain the commanding position she has so long occupied in skilled manufacture, the easy ways which (owing partly to the high qualities of her people, partly to the advantages of her insular position and mineral wealth) have sufficed for the past, will not be found to suffice for the future. The highest training which can be brought to bear on practical science will be imperatively required; and it will be a fatal policy if that training is to be sought for in foreign lands because it cannot be obtained at home. The country which depends unduly on the stranger for the education of its skilled men, or neglects in its highest places this primary duty, may expect to find the demand for such skill gradually pass away, and along with it the industry for which it was wanted. I do not claim for scientific education more than it will accomplish, nor can it ever replace the after-training of the workshop or factory. Rare and powerful minds have, it is true, often been independent of it; but high education always gives an enormous advantage to the country where it prevails. Let no one suppose I am now referring to elementary instruction, and much less to the active work which is going on everywhere around us, in preparing for examinations of all kinds. These things are all very useful in their way; but it is not by them alone that the practical arts are to be sustained in the country. It is by education in its highest sense, based on a broad scientific foundation, and leading to the application of science to practical purposes—in itself one of the noblest pursuits of the human mind—that this result is to be reached. That education of this kind can be most effectively given in a university, or in an institution like the Polytechnic School of Zurich, which differs from the scientific side of a university only in name, and to a large extent supplements the teaching of an actual university, I am firmly convinced; and for this reason, among others, I have always deemed the establishment in this country of Examining Boards with the power of granting degrees, but with none of the higher and more important functions of a university, to have been a measure of questionable utility. It is to Oxford and Cambridge, widely extended as they can readily be, that the country should chiefly look for the development of practical science; they have abundant resources for the task; and if they wish to secure and strengthen their lofty position, they can do it in no way so effectually as by showing that in a green old age they preserve the vigour and elasticity of youth.

If any are disposed to think that I have been carrying this meeting into dream-land, let them pause and listen to the result of similar efforts to those I have been advocating, undertaken by a neighbouring country when on the verge of ruin, and steadily pursued by the same country in the climax of its prosperity. "The University of Berlin," to use the words of Hofmann, "like her sister of Bonn, is a creation of our century. It was founded in the year 1810, at a period when the pressure of foreign domination weighed almost insupportably on Prussia; and it will ever remain significant of the direction of the German mind that the great men of that time should have hoped to develop, by high intellectual training, the forces necessary for the regeneration of their country." It is not for me, especially in this place, to dwell upon the great strides which Northern Germany has made of late years in some of the largest branches of

industry, and particularly in those which give a free scope for the application of scientific skill. "Let us not suppose," says M. Wurtz in his recent report on Artificial Dyes, "that the distance is so great between theory and its industrial applications. This report would have been written in vain, if it had not brought clearly into view the immense influence of pure science upon the progress of industry. If unfortunately the sacred flame of science should burn dimly or be extinguished, the practical arts would soon fall into rapid decay. The outlay which is incurred by any country for the promotion of science and of high instruction will yield a certain return; and Germany has not had long to wait for the ingathering of the fruits of her far-sighted policy. Thirty or forty years ago, industry could scarcely be said to exist there; it is now widely spread and successful." As an illustration of the truth of these remarks, I may refer to the newest of European industries, but one which in a short space of time has attained considerable magnitude. It appears (and I make the statement on the authority of M. Wurtz) that the artificial dyes produced last year in Germany exceeded in value those of all the rest of Europe, including England and France. Yet Germany has no special advantage for this manufacture except the training of her practical chemists. We are not, it is true, to attach undue importance to a single case; but the rapid growth of other and larger industries points in the same direction, and will, I trust, secure some consideration for the suggestions I have ventured to make.

The intimate relations which exist between abstract science and its applications to the uses of life have always been kept steadily in view by this Association, and the valuable Reports, which are a monument to the industry and zeal of its members, embrace every part of the domain of science. It is with the greater confidence, therefore, that I have ventured to suggest from this chair that no partition wall should anywhere be raised up between pure and applied science.

The same sentiment animates our vigorous ally, the French Association for the Advancement of Science, which, rivalling, as it already does, this Association in the high scientific character of its proceedings, bids fair in a few years to call forth the same interest in science and its results, throughout the great provincial towns of France, which the British Association may justly claim to have already effected in this country. No better proof can be given of the wide base upon which the French Association rests than the fact that it was presided over last year by an able representative of commerce and industry, and this year by one who has long held an exalted position in the world of science, and has now the rare distinction of representing in her historic Academies the literature as well as the science of France.

Whatever be the result of our efforts to advance science and industry, it requires no gift of prophecy to declare that the boundless resources which the supreme Author and Upholder of the Universe has provided for the use of man will, as time rolls on, be more and more fully applied to the improvement of the physical, and, through the improvement of the physical, to the elevation of the moral condition of the human family. Unless, however, the history of the future of our race be wholly at variance with the history of the past, the progress of mankind will be marked by alternate periods of activity and repose; nor will it be the work of any one nation or of any one race. To the erection of the edifice of civilised life, as it now exists, all the higher races of the world have contributed; and if the balance were accurately struck, the claims of Asia for her portion of the work would be immense, and those of northern Africa not insignificant. Steam-power has of late years produced greater changes than probably ever occurred before in so short a time. But the resources of nature are not confined to steam, nor to the combustion of coal. The steady water-wheel and the rapid turbine are more perfect machines than the stationary steam-engine; and glacier-fed rivers with natural reservoirs, if fully turned to account, would supply an unlimited and nearly constant source of power, depending solely for its continuance upon solar heat. But no immediate dislocation of industry is to be feared, although the turbine is already at work on the Rhine and the Rhone. In the struggle to maintain their high position in science and its applications, the countrymen of Newton and Watt will have no ground for alarm so long as they hold fast to their old traditions, and remember that the greatest nations have fallen when they relaxed in those habits of intelligent and steady industry upon which all permanent success depends.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY PROF. J. YOUNG, M.D., F.G.S., PRESIDENT OF THE SECTION.

When the British Association met in Glasgow twenty-one years ago, Sir Roderick Murchison presided over Section C, and was surrounded by a brilliant company, whose names, now historical, were even then familiar for their accuracy of observation, for philosophic generalisation, and for the eloquence with which their science was clothed in words that charmed while they instructed. Lyell, Hugh Miller, Sedgwick, Jukes, Smith of Jordan Hill, Thomas Graham, Agassiz, Salter, Leonard Horner, John Phillips, Robert Chambers, H. D. Rogers, Charles Maclaren, Sir W. Logan. The list is a heavy one even for twenty-one years, and the changed circumstances will be fully realised by Nicol, Harkness, Egerton, Darwin, Ramsay, and others when they find Murchison's place occupied by one who holds it rather by the courtesy of the Council to the Institution in which we are assembled than by any claim he has to the honour.

It would be out of place for me to do more than refer to the geological advantages which have given to Glasgow its commercial greatness. In the Handbook prepared at the instance of the Local Committee will be found gathered together all the positive knowledge we possess regarding the mineralogy, stratigraphy, and palæontology of the west of Scotland. The specimens themselves are exhibited in the Hunterian Museum and in the Corporation Galleries; and I take it upon me to say the Glasgow geologists are as ready as ever to assist the investigations of students in special departments with all the material which richly fossiliferous strata yield and the careful skill of assiduous collectors can secure.

Thus relieved from entering into local details, I would ask your attention for a short while to some of the difficulties which a teacher experiences in summarising the principles of geology for his students.

I may be pardoned for reminding you that as yet there are in Scotland only two specially endowed teachers of geology. In the Universities, that science for which Scotsmen had done so much received only the odd hours spared from zoology. In 1807 the two courses were separated in Glasgow; in 1870 Sir R. I. Murchison founded the Chair of Geology in Edinburgh; in 1876 Mr. Honyman Gillespie endowed a Lectureship on Geology in Glasgow, not separating it from zoology, but rather desiring the two to remain associated, while means were provided for tutorial instruction in the elementary work of the class. When next the Association meets in Glasgow, I hope that the services which science has rendered to mining and metallurgy may have been recognised by those who have reaped the benefit. During the efforts of years to obtain provision for systematic teaching in mining and metallurgy, practical and scientific have always been set in opposition by those whom I addressed. In another twenty years it may have become apparent that it is possible for a man to be both practical and scientific, and that the combination is most conducive to economy.

Geology occupies the anomalous position of being a science without a special terminology—a position largely the result of its history, but to some extent inherent in its subject-matter. Treated of by Hutton and Playfair and their opponents in the ordinary language of conversation, current phrases were adopted into science not so much acquiring special meanings as adding new ambiguities to those already existing. Every one seemed to understand them at once; and thus, as no one was obliged to attach very precise meanings to them, the instruments of research became its impediments, and the phrases in common use at the beginning of the century have transmitted to the present day the erroneous ideas of those by whom they were first employed. When Lyell, in 1832, methodised the knowledge accumulated prior to that date, he had, in organising the science, to choose between inventing an appropriate terminology and adopting that in common use. By doing the latter he promoted the popularity of the science, though at the cost of some subsequent confusion; by attempting the former he would have set in arms against him those who would, according to the pedantry of the time, have denounced his neologisms and formed in them a decorous veil for the objections which they entertained on other grounds to his views. Lyell was not the man to face the latter difficulty, nor can it be charged against him that he was wittingly neglectful of the interests of science. But to the use of conversational language are traceable certain assumptions to which I desire to draw your

attention. In venturing criticism of this kind, I am not unmindful of the Nemesis which has overtaken my colleague, Sir W. Thomson, for his comments on Lyell's language. Thomson took exception to language which implied a kind of perpetual motion—a circulation of energy at variance with the teaching of physics; and behold, two or three years after, Lockyer has published, as a physical astronomer, and Prestwich has approved, as a geologist, the opinion that the temperature of the sun may have fluctuated—that, in fact, changes of chemical combination may from time to time have refreshed the heat of the planet, whose uniform rate of cooling Sir William had assumed.

When stratigraphical geology first received due attention, the notion was prevalent that each formation terminated suddenly by cataclysm; it was therefore natural that the British succession—the earliest to be tabulated in detail—should be taken as a standard for other countries, and that the enumeration of the series should be a generalised section in which were incorporated those strata not present in Britain. The "intercalation" of beds thus practised to make an "incomplete" series "complete" still survives, as do the terms, though the notions which underlie them are formally denied by those who use them. A patriotic fellow-countryman once surprised us by his vehement denunciation of a treacherous Scot who called the Lanarkshire limestones meagre and incomplete as compared with the English. With knowledge he might have made his criticism useful; as it was he only gave a fresh example of the national peculiarity which, if it cannot prove Scotland to be better off than its neighbours, is content to make it out to be no worse. The abundant fossils of the Mesozoic strata of England and France rendered comparison easy, and created the impression that conchology was the A B C of geology, physical being subordinated to palæontological evidence. The balance has been somewhat restored by the Geological Survey, the precision of whose physical observations enables them to guide the palæontologist as often as guided by him. But one legacy from our predecessors we have not got rid of, nor indeed has its value been much called in question.

The process of intercalation had at first to do only with observed gaps into which obvious equivalents could be received. But as the needs of speculative biology rapidly increased, in the same ratio did belief in the imperfection of the geological record increase, till now we have that record described as a most fragmentary volume, nay as the remains of the last volume whose predecessors are lost to us.

Sir W. Thomson did good service by calling in question, on physical grounds, the indefinite extension backwards of geological time. The first fruits of his crusade were the definitions of Uniformitarianism and Evolution which Prof. Huxley gave. Henceforth no one will maintain the onesided notions regarding these two opposing views of the earth's history which were adopted in ignorant misconception or dictated by conceit and bigotry. But the service done was even greater, for while it became clear that a knowledge of physics was indispensable to him who would promulgate sound notions, it was further apparent that both biological and geological evolution had a limit in time; that in fact, on the assumption of the primitive incandescence of our globe, the date might be at least approximately fixed when the mechanical processes now at work commenced, and when the surface of the earth became habitable. Nothing more has yet been done than to point out the way; for, though Prof. Guthrie Tait indicates a limit of from fifteen to ten millions of years, that statement can only be regarded as in effect, though not perhaps in intention, as a protest against the liberality and vagueness of Sir W. Thomson's allowance, which gave geologists a range of one to two hundred millions of years.

The reconciliation of physicists and geologists is not likely to come through Mr. Lockyer's researches, even if the earth's history be shown to have been identical, unless the renewal of the earth's heat be shown to be compatible with continued life on the surface. If the reconciliation is looked for through the prolonged duration of the sun's life, that being the gauge of the earth's duration, the expectation is still based on the supposed need of very great time for geological processes, or rather on the supposed need of very great time for biological evolution, to which geological evolution has been squared. There is another direction in which these results may help us to meet the limitation assigned by the physicists; the intervals of variation of temperature may be shorter than those which separate the maxima of eccentricity of the earth's orbit, and thus the repeated cold periods of which we have suggestions in the stratified rocks, may have recurred within a shorter total period than is at present claimed.

It is scarcely within the compass of this address to enter into the questions involved, but it is permissible to indicate the reason for delaying meanwhile acceptance of any precise limit of time. There is as yet too much diversity of opinion as to the elements of the problem. Physicists are by no means at one as to the conditions which permit or prohibit shifting of the earth's axis. Calculations are based on the assumption of the regularity of the earth's form under a certain constant relation of the masses, albeit of diverse specific gravity, which compose it. It is moreover assumed that the ratio of land and water has been uniform, though the formation of the grand features of the land by contraction of the cooling mass has not yet been considered as affecting this assumption by altering the disposition of the water. On the one hand it has been shown that the existence of uniform temperatures over the earth's surface is a gratuitous hypothesis; on the other hand it is clear that the existing distribution of light and heat is incompatible with the flourishing of an abundant Carboniferous and Miocene flora within a short distance of the North Pole. One expects that astronomers will look to the shifting of the axis of rotation as the possible explanation of the difficulty, taking into account likewise the shifting of the centre of gravity necessarily following those displacements of matter which, on the contraction theory, have determined the positions of the main continents and oceans.

Mr. Evans, in his address to the Geological Society, referred to the deviation of the magnetic axis as perhaps due to such shifting of the materials composing the inner mass of our globe. May not the conjectures of M. Elie de Beaumont be after all in the right direction? May not the change of trend which led him to classify the mountain-chains by reference to the age at which they had been elevated, be associated with movements which did not in all cases result in shiftings of the earth's axis, so pronounced as those which permitted the Carboniferous and Miocene floras to invade successfully the Arctic Regions, or the phenomena of the glacial epoch or epochs, to manifest themselves in the low latitudes when their traces have been recognized?

Waiving, for the present, inquiry into the influence which the admission of a possible shifting of the earth's axis might have on our estimate of geological time, I shall return to the phraseology whose amendment seems advisable.

The confusion which exists is well illustrated in a remark by an eminent writer to the effect that the progress of geological research tends to prove the "continuity of geological time." The phrase in itself involves an absurdity; but what is meant is, that the successive so-called formations pass into each other by imperceptible gradation; and that, as time goes on, we shall be more and more able to intercalate strata so as to present a continuous scale of animal and vegetable forms. This is one out of many samples of the extreme length to which the thirst for strict correlation may go. We find in Murchison's writings and elsewhere pointed protests against the succession of strata in one district being held to rule that in other districts; but these are rather concessions wrung from their author by the pressure of particular instances than acknowledgments of a rule applicable to contiguous and to distinct localities alike. I could not perhaps take a better example than the strata which contain the remains of the fossil *Equidæ*. If we arrange the fossils in any series representing the modification of particular structures, or averaging the modifications of all the structures, we shall find that the terms of the series are met with, now in Europe, now in America; yet no one would venture to intercalate the European in the American Tertiary series so as to square the geological record with an assumed zoological standard. The notion of gradations, the extreme view of correlations has led to results which are, to put it mildly, of doubtful value. Yet it was a natural result of the work of Cuvier and other palæontologists among the Mesozoic and Eocene fossiliferous deposits. The statistical method invented by Lyell is simply a mode of gradations. Intercalation of strata is therefore a survival from an earlier stage of the science, and carries with it a distinct echo of the catastrophic notion that strata were formed simultaneously and generally over the earth's surface, if not universally.

The geological record has been compared to a volume of which pages have here and there disappeared; and the incompleteness of the record has been inferred from the frequency of pronounced gaps in the succession of strata. Of these gaps, these unconformities, Prof. Ramsay has shown the importance by demonstrating that they represent the lapse of unknown, but varying, and

in all cases, considerable periods of time. The intercalation of strata, assumed to fill up the gap, and hereby to give symmetry to systematic classifications, can only be done by an appeal to the statistical method, a fauna containing forms characteristic of higher and lower beds being assumed to represent an intermediate point in time, whereas it might be equally well claimed as representing an intermediate area in space, and as being possibly representative of the whole gap and of some of the strata above and below it.

The definition of a formation as representing a certain period of time, still repeated with various modifications, is to blame for this and several other curiosities of procedure. But the climax of symmetrical adjustments is reached when we find "natural groups" established—when, in other words, an attempt is made to show a regular periodicity of phenomena in geology. Dawson proposed a quarternary, Hull a ternary classification, to neither of which should I now refer, but that the deserved estimation of these writers is apt to perpetuate what seems to be an unsafe view of geological succession.

Hull's arrangement has the merit, by force of its simplicity, of bringing the vainness of the attempt into prominence. Dawson has complicated his classification so as to render it impracticable. A natural group of strata, one in which elevation, deep depression, elevation, record themselves in rocks so as to establish geological cycles, implies several things for which we have no evidence. Most important of all does it imply, that the events above noted should recur in every area in the same order, that they should recur at equal intervals of time, and therefore yield equal masses of strata, and above all that the superior and inferior limits of each natural and coterminous group should consist of a mass of similar strata, one portion of which shall belong to the earlier, the other to the later group. Here then we have implied, not catastrophic simplicity as regards the strata, but something very like it as regards the subterranean forces.

Mr. Hull has not, however, been able to surrender himself wholly to his speculation. He has admitted "gaps," breaks, that is to say, for which he finds no equivalents in the British series; the strata that should occupy these gaps having been either removed by denudation or never deposited, the British area being at these times above water. The concession is fatal to the scheme. But the very use of the word gap recalls the phrases "complete and incomplete," and their nearest of kin "base of a formation." Prof. Ramsay used the word "break" to mark his unconformities, but no term has been proposed for "the base of a formation." The term was in constant use when such base was always claimed to be a conglomerate. That notion is now exploded, but no distinction is drawn between the lowest bed of a group of conformable strata, and the bed or beds which repose unconformably on those below them. Thus, the London basin has the Thanet beds, the Reading beds, and the London clay successively resting on the chalk, and each of these is the base for its proper locality, unless it be asserted that in this and similar cases the lowest beds once covered a wider area, and were then removed. But a more important case is presented by the great calcareous accumulations of the Carboniferous and Chalk series. The Lower Greensand is to the latter series in England what the lowest stratum of the Chalk would be if we could get at it. The Carboniferous Limestone rests directly on the Red Sandstone in central England, farther north it rests on the Calciferous Sandstones. Thus the base of the formation varies according to locality, or rather according to the circumstances of deposition, and we need a term which would indicate a difference between the conformable and unconformable succession. Mr. Judd has lamented the equivocal use by English writers, of the term formation, which etymologically is as well applied to the Chalk without flints as to the whole Cretaceous series. He advocates "system" as applicable to the larger groups, the Cretaceous system for example. But it seems as if the time were come for still further restrictions of either or both terms.

The analogy of the geological record to an incomplete volume is, like most analogies, at once imperfect and misleading. Rather might the record be compared to the fragments of two volumes which have come to be bound together, so that it is not possible to recognise the sequence. Or perhaps it might be better compared to a universal history in which, by omission of dates, the chronology is thoroughly obscured, and the necessary treatment of each nation by itself conceals the contemporaneity of events. We have the aquatic record and the terrestrial record, and these two are going on simultaneously. It is as yet, and probably always will be impossible to recognise the marine deposits which correspond to the terrestrial remains, save perhaps in the most recent geological times. We now know that the life of the Cretaceous seas is not wholly extinct in the existing Atlantic Ocean, but exists there to an extent which would entitle the deposits of that area to rank by the statistical method as intermediate between the Cretaceous and the Tertiary. It is obviously impossible to include under one term deposits which are associated with geographical changes so important as those commonly accepted as having prevailed during the Tertiary epoch. The Meosozoic forms pass gradually into the Tertiary, how gradually we cannot say, since the deep sea equivalents of the European Tertiaries are not certainly known to us. But as a portion survives to the present day, and as, presumably, the extinction was not rapid (for it is only in the case of land animals that sudden disappearances are as yet probable), it is obvious that the successor, the heir of the Chalk, was not the Eocene, nor necessarily the Miocene known to us, but probably deposits still buried under the Atlantic.

My object is to show that, even the limitation of time which Prof. Tait prescribes for us, may not after all be too narrow for the processes which have resulted in our known stratigraphy. Mr. Darwin speaks of the geologic record being the imperfect record of the last series of changes, the indefinite extension of time anterior to the earliest fossiliferous rocks being necessary for the full evolution of organic forms. But is there any ground for the assumption? True that the Laurentians contain fragments of antecedent rock, but were these fossiliferous? Are they the remains of land surfaces on which living beings flourished, or are they only the *débris* of the first consolidated portion of the earth's crust on which if organisms existed they may have been the most primitive of our organic series? Mr. Jukes refers to the possibility of such earlier strata having existed, but he wrote when geologists were dominated with the belief in the indefiniteness of geological time. Now we are brought by physicists, like Sir W. Thomson and Captain Dutton, to face the question—is there evidence of such earlier masses of stratified deposits? If we allow to the physical argument all the weight to which its advocates deem it entitled, if we accept fifteen millions of years, nay, even if we admit one hundred millions of years as our limit, it follows that we may still regard the earth as in its first stage of cooling. But when we turn to the geological evidence, all that can be advanced is that the Laurentian strata contain fragments presumably derived from earlier strata; but metamorphosed fragments, among metamorphic rocks are not the most reliable guides, and there is the positive evidence that the Laurentian area has not been covered to any extent, if at all, by later deposits. So far as direct proof goes, therefore, we have none that the earliest known stratified rocks are not also the earliest deposited after cooling. Even if we disregard the limits imposed by the philosophers, liberal though they are in Sir W. Thomson's hands, the absence of proof that later deposits covered Laurentian areas seems entitled to greater weight than is usually allowed to negative evidence. At best the assertion of antecedent strata is an arbitrary one, which any of us is at liberty to contradict, and in favour of which no physical evidence, and only zoological prejudices can be adduced. The earliest stratified deposits known are the Laurentian, and they are, so far as we know, the earliest to have been deposited.

But apart from these possible though improbable earlier deposits, geological time is said to be lengthened by the missing strata of later periods. Mr. Croll has given great prominence to this, which is another of the things taken for granted in geology, commenting on Mr. Huxley's remark that if deposit went on at the rate of 1 foot for 1,000 years, the 100,000 feet of strata assumed by him to form the earth's crust, would be laid down in the 100 millions of years which Sir W. Thomson had given as the limit. But, says Mr. Croll, what of the missing strata? It is commonly said that we have only a part of the deposits of any period, that the last have been denuded away, and that thus the time needed for their deposit and for their subsequent removal are out of our knowledge. This is based on what we see on the shore when the tide rises and falls and washes off at each turn a part of the sand and mud laid down in the interval. But the older deposits were laid down in deeper water than that between tide-marks, and were for the most part laid down during subsidence. Even admitting removal of part of the strata to have taken place during re-emergence, the quantity so withdrawn cannot be proved to represent more than a small fraction of the total. To provide the needed elongation of geological time by an appeal to arbitrary speculations is not admissible. Belief on belief is, as Butler says, bad heraldry. The denudation to which importance is justly ascribed is that

represented by unconformity. Re-elevation has been accompanied by disturbance of the area from a different centre than that around which subsidence took place. The strata are worn obliquely, and thus thickness of the mass at one place is greatly diminished, though it does not follow in all cases that the maximum thickness of the strata has been effected.

The importance, as I deem it, the excessive importance which is attached to the missing strata is asserted by biologists who, apparently unconsciously, seek to gain, by prolonging the interval between successive groups, the time which ought rather to be sought for in tracing, were that possible, the migrations of the species which seem to have suddenly died out. In other words there is a reversion to the older ideas regarding the succession of strata which are embodied in such phrases as the Age of Fishes, the Age of Reptiles, and the like.

But the inequality of surface which unconformity involves, entails that other consequence that the maximum thicknesses of the two masses of deposits do not coincide in position. Hence the thickness of the strata in the area will be exaggerated, the time spent in deposit also exaggerated, if the two thicknesses are put together. This has been done by Mr. Darwin in drawing inferences from the measurements given him by Prof. Ramsay, measurements which, on the face of them, do not represent a continuous pile of rock. Mr. Darwin assumes either that the Welsh Hills (not to speak of the Hebrides) were covered by all the later strata now denuded or that if we sink a bore, say on the east coast, we should go through the whole series as tabulated. When Prof. Huxley took 100,000 feet as the thickness of the sedimentary series, the same notion was unconsciously present, the same survival of catastrophism, the onion-coat theory as Herbert Spencer named it.

The Geological Survey has corrected its tables in one important direction; it has shown the contemporaneity of unlike groups in different parts of Britain, the distinct types of the old red sandstone, carboniferous, permian, and purbecks being placed in parallel columns. To some extent this is a curtailment of the thickness of the rock series, the dissimilar strata are not piled on each other. But the curtailment might be carried still farther. The marine and terrestrial conditions are simultaneous; if we could identify the dry land for each deep sea we should have possibly the overlap of periods producing extraordinary combinations, though not perhaps of Mesozoic and Palæozoic faunas contemporaneous. But the British series may be tabulated as follows:—

Land Surfaces.	*Lacustrine and Fluviatile.*	*Marine.*
		Laurentian?
	Cambrian.	Silurian.
	Old Red Sandstone	
	Calciferous Sandstones.	Carboniferous Limestone
Coal Measures.		
Permian		Jurassic.
Trias		
Purbeck.		Neocomian
Wealden.		
Miocene.		Cretaceous
Pleistocene.		

In the case of the Cretaceous series, Mr. Ramsay has given illustration of the ingenious views of De La Beche regarding the contemporaneity of deposits superposed one on the other. The Lower Greensand is contemporaneous with part of the Chalk, so were parts of the Wealden: nay, even of the Purbecks a portion must have been forming while the Cretaceous sea was gradually deepening southward and eastward.

It may be said that the recognition of the parallelism would not make very much difference after all; that it would not one whit lessen the time spent in forming 500 feet of rock to know that there was elsewhere another 500 feet formed at the same time. But the shortening of the geological list by striking out the overlaps of the formations and thus counting them only once is of itself a matter of some consequence, since the maximum thickners of the Cretaceous being nearly 3,000 feet and that of the Weald 1,500 feet, even the partial coincidence, in time, of these masses, would, on Mr. Croll's calculation of 1 foot of deposit per 1,000 years, make a considerable difference in the chronology, still more if the Carboniferous Limestone be set against its probable contemporaries the Upper Old Red Sandstone and Coal-measures. Mr. Jukes' bold erasure of the Devonians was of itself a very important change on the chronological table, and I doubt not others may yet be achieved. But, it may be said, the Cretaceous still rests on the Wealden; the vertical thickness still remains. But is the ordinary method of estimating the thickness quite reliable? In some cases, as in the productive coal-measures, there is tolerable uniformity; but among the lower coals and the Mesozoic strata, where the strata or groups of strata are not regular, the maximum thicknesses of all are, as has been already shown, apt to be taken, and thus an aggregate more or less in excess of the real thickness results.

But recurring to an objection already referred to, arrange it as you like, you get, say in Wales, a known thickness of 50,000 feet. But the rocks there are tilted, and the absolute depth which they attain in this position is unknown. In North America the Laurentians are estimated at 30,000 feet; but though there is every reason to believe that they have not been covered to any extent with later deposits, the total thickness of sedimentary crust is, for the same reason as in Wales, unknown. Bigsby has shown how varied are the surfaces on which the later deposits are laid down; how great, therefore, must be the deductions from the same total of maximum or even average thickness of all formations before we approximate to the actual thickness of sedimentary deposits at any one point. But take the actual thickness in Wales as given in Jukes's Manual from the Survey data: for the Cambrians we have from 23-28,000 feet; Silurians, Upper and Lower, not counting breaks by unconformities, 20,000. If denudation takes place at the rate of 1 foot in 6,000 years, and deposit at the same rate, we should have for the Silurians alone 120,000,000 of years needed. If, however, deposit takes place at the rate of 1 foot in 14,400 years, 288,000,000 millions of years would be needed for the accumulation of the surviving strata. It is obvious that the rate of deposit or denudation, or both is misunderstood. The stratified rocks equal in amount the material denuded; if we knew the total amount of denudation we should know, not merely the residuum of rock open to our inspection, but the total amount of stratified deposits which had been formed, or at least approximately, for the deposit of materials removed is not synchronous with their removal. Obviously these elements are not known, and cannot be known to us. Mr. Croll, who has investigated the question theoretically, assumes that deposit and denudation take place in equal times, and assumes further a uniform distribution over the whole or over a part of the sea-bottom. But Prof. Geikie's table shows that, if we are to take averages as a safe guide, the land is lowered at the rate of two in 6,000 years. Moreover, if, as Mr. Croll points out, deposit was less during the glacial epoch, the process must have been more rapid since, and thus an irregularity is introduced which impairs the value of the calculations. Prof. Hughes, in the brief abstract of his Royal Institution address, which alone I have had the opportunity of seeing, contests the validity of any estimates of time on the basis of our existing knowledge. I do not mean to enter into this question, but I may be allowed to remark that any conclusions, founded on mean thickness of sedimentary formations are of no value. It is not the time necessary for the building up of a mean thickness, but that necessary for the formation of the maximum thickness in particular regions which we have to consider.

If the Laurentian rocks and their equivalents are to be regarded as the earliest stratified deposits, or rather, if there is no reason for believing that they were preceded by other stratified rocks, the relation of Huxley's homotaxis to any classification of strata having the Laurentians as a fixed point is worth investigating. The universal diffusion of species in the earlier strata was first the accepted creed of geologists. Then it was denied, though the language of the earlier faith continued current. Again, we return towards the doctrine of extensive simultaneous diffusion, but under a very much modified form. The *Challenger* reports bear testimony to the wide distribution of forms in the deepest oceans, and when we turn from these and compare the lists of fossil species so found widely distributed, it appears that here again we have oceanic forms, or at any rate those found in such limestones as are safely assigned to a deep water origin. Ramsay has shown that the continental epochs in Western Europe overlasted considerable periods of time. The antiquity of the Atlantic and Pacific is certain; even their primitive character is possible. Thus there are two conditions—land and deep sea—reasoning regarding which must be quite different from that applicable to the intermediate conditions. It is exactly these intermediate states which present practical and speculative difficulty. Theories which account for mountains and oceans fail to explain the "oscillations" which were wont to be appealed to when terrestrial and marine surfaces succeeded each other. But the assumed movement of the land is by no means a certainty, and as in the kindred case of faults, we need terms which shall be neutral, whether the land has moved upwards or the sea shrunk downwards. The terms Palæozoic, Mesozoic, and Cain-

zoic have long held their places from the reluctance to disturb established nomenclature, as well as from the difficulty of inventing appropriate substitutes; but if retained at all, we know now that the relations they represent are not the same for the terrestrial, the deep oceanic, and the intermediate areas, any more than the life is the same under those three conditions.

I have once before called attention to a grave difficulty in the physical geography of Scotland; and as Mr. Seeley has since then raised the same question without obtaining an answer, I would again state the case as one which seems to involve the revisal of some definitions.

The Silurian hills of South Scotland are commonly said to have been covered by Old Red Sandstone and even by Carboniferous strata, patches of these rocks being met with on the south side of the fault which defines these hills with their abrupt, coast-like margin seen from Edinburgh, or from Symington station on the Caledonian line. But the surface of these Silurians was denuded before the Old Red times, as Mr. Geikie has showed. Nay, valleys existed as now, and in the same positions as now. At the present time the rivers flow in identically the same valleys, in at least the cases of the Nith, the Annan, the Lauder, and the Liddell; and the boundaries of the areas are so well known that we can safely assert no buried channel to exist such as we find on the tributaries of the Clyde. That the channels were occluded in glacial times we may take for certain; that the obstruction has been washed away and the courses cleared is equally certain. The surface contours were not materially altered, so that the retreating ice left hollows in the position of the old valleys. But the case is quite different when we deal with the older rocks. Their succession is marked by unconformities and overlaps, which it is impossible to picture as associated with full preservation of the surface features on which they were laid down; and when the thickness comes to be as much as 1,000 feet or more, and of that thickness a part at least made up of marine strata, the relapse of all the streams to their old causes is an event of the highest improbability. Mr. Topley has pointed out how the dip of strata may, under certain circumstances, coincide with their thinning out to the margins of their area of deposit, changes of angle in highly inclined strata pointing in the same direction. The ordinary rule of protracting strata, and thus restoring their thickness over the adjacent high ground, is, in the case, at least, of South Scotland, a method which imposes on atmospheric denudation, even if aided by the sea, a most complicated task.

Had time permitted, it might have been interesting to note the changing phraseology regarding faults, and the pertinacity with which phrases involving the most unsatisfactory and improbable causation continue to be used. Upcast and downcast, upthrow and downthrow, displacement upwards or downwards—these it may be said are of small importance; they are only symbols. But in the first place they are mischievous so far as they give students confused ideas with which to contend, and in the second place the continued acceptance of loose phraseology is peculiar to geology; even in metaphysics, where the subject matter is much more conveniently discussed in ordinary language, new terms are employed to a great extent. But important as I therefore regard these terms from the teacher's point of view, the greater importance attaches to the accuracy of the notions which underlie our language regarding the processes and rates of deposit and denudation.

So far as our present knowledge goes, we must accept it as certain that there is some limit to the duration of the earth in the past. Neither philosophers nor astronomers are agreed on the essential points of the problem, nor have they considered all the possible changes in the position of the earth's axis, and in the rate at which the earth loses heat. The limits hitherto prescribed are so discrepant that we cannot as yet accept any as fixed. Neither have geologists so accurate a knowledge of geological processes that they can speak with confidence either of the absolute or relative rates at which rock formation has advanced. The geologist has hitherto asked for more time, not because he himself was aware of his need, but from a generous regard for the difficulties in which his zoological brother found himself when he attempted to explain the diversity of the animal series as the result of slowly-operating causes. The geologist asked for more time simply because he could form no just estimate of what was needed for the physical processes with whose results he was familiar. But palæontological domination is now at an end; and the increasing number of geologists, who are also competent physicists and mathematicians, seems to mark a new school, which will strive to interpret more precisely the accumulated facts. Such at least seems the history of the past fifteen or twenty years. Such seems the direction in which speculation now tends, and in the foregoing remarks I have endeavoured faithfully to represent the drift of our science. To many here present much of what I have said is already familiar; I therefore give place to the more legitimate business of the Section, looking to receive elsewhere "such censures as may be my lot."

SECTION D.

Biology.

Opening Address by the President, Alfred Russel Wallace.

Introduction.

The range of subjects comprehended within this Section is so wide, and my own acquaintance with them so imperfect and fragmentary, that it is not in my power to lay before you any general outline of the recent progress of the biological sciences. Neither do I feel competent to give you a summary of the present status of any one of the great divisions of our science—such as Anatomy, Physiology, Embryology, Histology, Classification, or Evolution—Philology, Ethnology, or Prehistoric Archæology; but there are fortunately several outlying and more or less neglected subjects to which I have for some time had my attention directed, and which I hope will furnish matter for a few observations, of some interest to biologists, and at the same time not unintelligible to the less scientific members of the Association who may honour us with their presence.

The subjects I first propose to consider have no general name, and are not easily grouped under a single descriptive heading; but they may be compared with that recent development of a sister-science, which has been termed Surface-geology or Earth-sculpture. In the older geological works we learnt much about strata, and rocks, and fossils, their superposition, contortions, chemical constitution, and affinities, with some general notions of how they were formed in the remote past; but we often came to the end of the volume no whit the wiser as to how and why the surface of the earth came to be so wonderfully and beautifully diversified; we were not told why some mountains are rounded and others precipitous; why some valleys are wide and open, others narrow and rocky; why rivers so often pierce through mountain-chains; why mountain lakes are often so enormously deep; whence came the gravel, and drift, and erratic blocks, so strangely spread over wide areas while totally absent from other areas equally extensive. So long as these questions were almost ignored, geology could hardly claim to be a complete science, because, while professing to explain how the crust of the earth came to be what it is, it gave no intelligible account of the varied phenomena presented by its surface. But of late years these surface-phenomena have been assiduously studied; the marvellous effects of denudation and glacial action in giving the final touches to the actual contour of the earth's surface, and their relation to climatic changes and the antiquity of man, have been clearly traced, thus investing geology with a new and popular interest, and at the same time elucidating many of the phenomena presented in the older formations.

Now, just as a surface-geology was required to complete that science, so a surface-biology was wanted to make the science of living things more complete and more generally interesting, by applying the results arrived at by special workers, to the interpretation of those external and prominent features whose endless variety and beauty constitute the charm which attracts us to the contemplation or to the study of nature. We have the descriptive zoologist, for example, who gives us the external characters of animals; the anatomist studies their internal structure; the histologist makes known the nature of their component tissues; the embryologist patiently watches the progress of their development; the systematist groups them into classes and orders, families, genera, and species; while the field-naturalist studies for us their food and habits and general economy. But till quite recently, none of these earnest students, nor all of them combined, could answer satisfactorily, or even attempted to answer, many of the simplest questions concerning the external characters and general relations of animals and plants. Why are flowers so wonderfully varied in form and colour? what causes the Arctic fox and the ptarmigan to turn white in winter? why are there no elephants in America and no deer in Australia? why are closely allied species rarely found together? why are male animals so frequently bright coloured? why are extinct animals so often larger than those which are now living? what has led to the

production of the gorgeous train of the peacock and of the two kinds of flower in the primrose? The solution of these and a hundred other problems of like nature, was rarely approached by the old method of study, or if approached was only the subject of vague speculation. It is to the illustrious author of the "Origin of Species" that we are indebted, for teaching us how to study nature as one great, compact, and beautifully adjusted system. Under the touch of his magic wand the countless isolated facts of internal and external structure of living things—their habits, their colours, their development, their distribution, their geological history,—all fell into their approximate places; and although from the intricacy of the subject and our very imperfect knowledge of the facts themselves, much still remains uncertain; yet we can no longer doubt that even the minutest and most superficial peculiarities of animals and plants either, on the one hand, are or have been useful to them, or, on the other hand, have been developed under the influence of general laws, which we may one day understand to a much greater extent than we do at present. So great is the alteration effected in our comprehension of nature by the study of variation, inheritance, cross-breeding, competition, distribution, protection, and selection—showing, as they often do, the meaning of the most obscure phenomena, and the mutual dependence of the most widely-separated organisms, that it can only be fitly compared with the analogous alteration produced in our conception of the universe by Newton's grand discovery of the law of gravitation.

I know it will be said (and is said), that Darwin is too highly rated; that some of his theories are wholly and others partially erroneous, and that he often builds a vast superstructure on a very uncertain basis of doubtfully interpreted facts. Now, even admitting this criticism to be well founded—and I myself believe that to a limited extent it is so—I nevertheless maintain that Darwin is not and cannot be too highly rated. For his greatness does not at all depend upon his being infallible, but on his having developed, with rare patience and judgment, a new system of observation and study, guided by certain general principles which are almost as simple as gravitation, and as wide-reaching in their effects. And if other principles should hereafter be discovered, or if it be proved that some of his subsidiary theories are wholly or partially erroneous, this very discovery can only be made by following in Darwin's steps, by adopting the method of research which he has taught us, and by largely using the rich stores of material which he has collected. The "Origin of Species," and the grand series of works which have succeeded it, have revolutionised the study of biology. They have given us new ideas and fertile principles. They have infused life and vigour into our science, and have opened up hitherto unthought of lines of research on which hundreds of eager students are now labouring. Whatever modifications some of his theories may require, Darwin must none the less be looked up to as the founder of philosophical biology.

As a small contribution to this great subject, I propose now to call your attention to some curious relations of organisms to their environment, which seem to me worthy of more systematic study than has hitherto been given them. The points I shall more especially deal with are—the influence of locality, or of some unknown local causes, in determining the colours of insects and, to a less extent, of birds; and the way in which certain peculiarities in the distribution of plants may have been brought about by their dependence on insects. The latter part of my address will deal with the present state of our knowledge as to the antiquity and early history of mankind.

On some Relations of Living Things to their Environment.

Of all the external characters of animals, the most beautiful, the most varied, and the most generally attractive, are the brilliant colours and strange yet often elegant markings with which so many of them are adorned. Yet, of all characters, this is the most difficult to bring under the laws of utility or of physical connection. Mr. Darwin—as you are well aware—has shown how wide is the influence of sex on the intensity of colouration; and he has been led to the conclusion that active or voluntary sexual selection is one of the chief causes, if not the chief cause, of all the variety and beauty of colour we see among the higher animals. This is one of the points on which there is much divergence of opinion even among the supporters of Mr. Darwin, and [illegible] as to which I myself differ from him. I have argued, and [illegible] believe, that the need of protection is a far more efficient [illegible] of variation of colour than is generally suspected; but there are evidently other causes at work, and one of these seems to be an influence depending strictly on locality, whose nature we cannot yet understand, but whose effects are everywhere to be seen when carefully searched for.

Although the careful experiments of Sir John Lubbock have shown that insects can distinguish colours—as might have been inferred from the brilliant colours of the flowers which are such an attraction to them—yet we can hardly believe that their appreciation and love of distinctive colours is so refined as to guide and regulate their most powerful instinct—that of reproduction. We are therefore led to seek some other cause for the varied colours that prevail among insects; and as this variety is most conspicuous among butterflies,—a group perhaps better known than any other—it offers the best means of studying the subject. The variety of colour and marking among these insects is something marvellous. There are probably about ten thousand different kinds of butterflies now known, and about half of these are so distinct in colour and marking that they can be readily distinguished by this means alone. Almost every conceivable tint and pattern is represented, and the hues are often of such intense brilliance and purity as can be equalled by neither birds nor flowers.

Any help to a comprehension of the causes which may have concurred in bringing about so much diversity and beauty must be of value, and this is my excuse for laying before you the more important cases I have met with of a connection between colour and locality.

Our first example is from tropical Africa, where we find two unrelated groups of butterflies belonging to two very distinct families (Nymphalidæ and Papilionidæ) characterised by a prevailing blue green colour not found in any other continent.[1] Again, we have a group of African Pieridæ which are white or pale yellow with a marginal row of bead-like black spots, and in the same country one of the Lycænidæ (*Liptena crastus*) is coloured so exactly like these that it was at first described as a species of *Pieris*. None of these four groups are known to be in any way specially protected so that the resemblance cannot be due to protective mimicry.

In South America we have far more striking cases. For in the three sub-families—Danainæ, Acræinæ, and Heliconiinæ—all of which are specially protected, we find identical tints and patterns reproduced, often in the greatest detail, each peculiar type of coloration being characteristic of distinct geographical subdivisions of the continent. Nine very distinct genera are implicated in these parallel changes—*Lycorea*, *Ceratinia*, *Mechanitis*, *Ithomia*, *Melinæa*, *Tithorea*, *Acræa*, *Heliconius*, and *Eueides*—groups of three or four (or even of five) of them appearing together in the same livery in one district, while in an adjoining district most or all of them undergo a simultaneous change of coloration or of marking. Thus in the genera *Ithomia*, *Mechanitis*, and *Heliconius*, we have species with yellow apical spots in Guiana, all represented by allied species with white apical spots in South Brazil. In *Mechanitis*, *Melinæa*, and *Heliconius*, and sometimes in *Tithorea*, the species of the Southern Andes (Bolivia and Peru) are characterised by an orange and black livery, while those of the Northern Andes (New Grenada) are almost always orange-yellow and black. Other changes of a like nature, which it would be tedious to enumerate, but which are very striking when specimens are examined, occur in species of the same groups inhabiting these same localities, as well as Central America and the Antilles. The resemblance thus produced between widely different insects is sometimes general, but often so close and minute that only a critical examination of structure can detect the difference between them. Yet this can hardly be true mimicry, because all are alike protected by the nauseous secretion which renders them unpalatable to birds.

In another series of genera (*Catagramma*, *Callithea*, and *Agrias*), all belonging to the Nymphalidæ, we have the most vivid blue ground, with broad bands of orange-crimson or a different tint of blue or purple, exactly reproduced in corresponding, yet unrelated species, occurring in the same locality; yet, as none of these groups are protected, this can hardly be true mimicry. A few species of two other genera in the same country (*Eunica* and *Siderone*) also reproduce the same colours, but with only a general resemblance in the marking. Yet again, in Tropical America we have species of *Apatura* which, sometimes in both sexes, sometimes in the female only, exactly imitate the peculiar markings of another genus (*Heterochroa*) confined to America. Here, again, neither genus is protected, and the similarity must be due to unknown local causes.

[1] *Romaleosoma* and *Euryphene* (Nymphalidæ), *Papilio zalmoxis*, and several species of the *Nireus* group (Papilionidæ).

But it is among islands that we find some of the most striking examples of the influence of locality on colour, generally in the direction of paler, but sometimes of darker and more brilliant hues, and often accompanied by an unusual increase of size. Thus, in the Moluccas and New Guinea we have several Papilios (*P. euchenor*, *P. ormenus*, and *P. tydeus*), distinguished from their allies by a much paler colour, especially in the females, which are almost white. Many species of *Danais* (forming the sub-genus *Ideopsis*) are also very pale. But the most curious are the Euplæas, which, in the larger islands, are usually of rich dark colours, while in the small islands of Banda, Ké, and Matabello at least three species not nearly related to each other (*E. hoppferi*, *E. euripon*, and *E. assimilata*) are all broadly banded or suffused with white, their allies in the larger islands being all very much darker. Again, in the genus *Diadema*, belonging to a distinct family, three species from the small Aru and Ké islands (*D. deois*, *D. hewitsonii*, and *D. polymena*) are all more conspicuously white-marked than their representatives in the larger islands. In the beautiful genus *Cethosia*, a species from the small island of Waigiou (*C. cyrene*), is the whitest of the genus. *Prothoe* is represented by a blue species in the continental island of Java, while those inhabiting the ancient insular groups of the Moluccas and New Guinea are all pale yellow or white. The genus *Drusilla*, almost confined to these islands, comprises many species which are all very pale; while in the small island of Waigiou is found a very distinct genus, *Hyantis*, which, though differing completely in the neuration of the wings, has exactly the same pale colours and large ocellated spots as *Drusilla*. Equally remarkable is the fact that the small island of Amboina produces larger-sized butterflies than any of the larger islands which surround it. This is the case with at least a dozen butterflies belonging to many distinct genera,[1] so that it is impossible to attribute it to other than some local influence. In Celebes, as I have elsewhere pointed out,[2] we have a peculiar form of wing and much larger size running through a whole series of distinct butterflies, and this seems to take the place of any specialty in colour.

From the Fiji Islands we have comparatively few butterflies, but there are several species of *Diadema* of unusually pale colours, some almost white.

The Philippine Islands seem to have the peculiarity of developing metallic colours. We find there at least three species of *Euplæa*[3] not closely related, and all of more intense metallic lustre than their allies in other islands. Here also we have one of the large yellow Ornithopteræ (*O. magellanus*), whose hind wings glow with an intense opaline lustre not found in any other species of the entire group; and an *Adolias*[4] is larger and of more brilliant metallic colouring than any other species in the Archipelago. In these islands also we find the extensive and wonderful genus of weevils, *Pachyrhynchus*, which in their brilliant metallic colouring surpass anything found in the whole eastern hemisphere, if not in the whole world.

In the Andaman Islands, in the Bay of Bengal, there are a considerable number of peculiar species of butterflies differing slightly from those on the continent, and generally in the direction of paler or more conspicuous colouring. Thus, two species of *Papilio*, which on the continent have the tails black, in their Andaman representatives have them either red- or white-tipped.[5] Another species[6] is richly blue-banded where its allies are black; while three species of distinct genera of Nymphalidæ[7] all differ from their allies on the continent in being of excessively pale colours, as well as of somewhat larger size.

In Madagascar we have the very large and singularly white-spotted *Papilio antenor*, while species of three other genera[8] are very white or conspicuous, compared with their continental allies.

Passing to the West Indian Islands and Central America (which latter country has formed a group of islands in very recent times), we have similar indications. One of the largest of the Papilios inhabits Jamaica,[9] while another, the largest of its

[1] *Ornithoptera priamus*, *O. helena*, *Papilio deiphobus*, *P. ulysses*, *P. gambrisius*, *P. codrus*, *Iphias leucippe*, *Euplæa prothoe*, *Hestia idea*, *Athyma jocaste*, *Diadema pandarus*, *Nymphalis pyrrhus*, *N. euryalus*, *Drusilla jairus*.

[2] "Contributions to the Theory of Natural Selection," pp. 168–173.

[3] *Euplæa hewitsonii*, *E. diocletiana*, *E. lætifica*, *E. dupesnii*.

[4] *Adolias calliphorus*.

[5] *Papilio rhodifer* (near *P. doubledayi*) and *Papilio charicles* (near *P. memnon*).

[6] *Papilio mayo*.

[7] *Euplæa andamanensis*, *Cethosia biblis*, *Cyrestis cocles*

[8] *Danais nossima*, *Melanitis massoura*, *Diadema dexithea*.

[9] *Papilio homerus*.

group, is found in Mexico.[1] Cuba has two of the same genus whose colours are of surpassing brilliancy;[2] while the fine genus *Clothilda*—confined to the Antilles and Central America—is remarkable for its rich and showy colouring.

Persons who are not acquainted with the important structural differences that distinguish these various genera of butterflies, can hardly realise the importance and the significance of such facts as I have now detailed. It may be well, therefore, to illustrate them by supposing parallel cases to occur among the mammalia. We might have, for example, in Africa, the gnus, the elands, and the buffaloes all coloured and marked like zebras, stripe for stripe over the whole body exactly corresponding. So the hares, marmots, and squirrels of Europe might be all red, with black feet, while the corresponding species of Central Asia were all yellow, with black heads. In North America we might have raccoons, squirrels, and opossums in parti-coloured livery of white and black, so as exactly to resemble the skunk of the same country; while in South America they might be black, with a yellow throat patch, so as to resemble with equal closeness the tayra of the Brazilian forests. Were such resemblances to occur in anything like the number, and with the wonderful accuracy of imitation met with among the Lepidoptera, they would certainly attract universal attention among naturalists, and would lead to the exhaustive study of the influence of local causes in producing such startling results.

One somewhat similar case does indeed occur among the Mammalia, two singular African animals, the Aard-wolf (*Proteles*) and the Hyæna-dog (*Lycaon*), both strikingly resembling hyænas in their general form as well as in their spotted markings. Belonging as they all do to the Carnivora, though to three distinct families, it seems quite an analogous case to those we have imagined; but as the Aard-wolf and the hyæna-dog are both weak animals compared with the hyæna, the resemblance may be useful, and in that case would come under the head of mimicry. This seems the more probable because, as a rule, the colours of the Mammalia are protective, and are too little varied to allow of the influence of local causes producing any well-marked effects.

When we come to birds, however, the case is different; for although they do not exhibit such distinct marks of the influence of locality as do butterflies—probably because the causes which determine colour are in their case more complex—yet there are distinct indications of some effect of the kind, and we must devote some little time to their consideration.

One of the most curious cases is that of the parrots of the West Indian Islands and Central America, several of which have white heads or foreheads, occurring in two distinct genera,[3] while none of the more numerous parrots of South America are so coloured. In the small island of Dominica we have a very large and richly-coloured parrot (*Chrysotis augusta*) corresponding to the large and richly-coloured *Papilio homerus* of Jamaica.

The Andaman Islands are equally remarkable, at least six of the peculiar birds differing from their continental allies in being much lighter, and sometimes with a large quantity of pure white in the plumage,[4] exactly corresponding to what occurs among the butterflies.

In the Philippines this is not so marked a feature,—yet we have here the only known white-breasted Kingcrow (*Dicrurus mirabilis*),—the newly discovered *Eurylæmus Steerii*, wholly white beneath,—three species of *Dicæum*, all white beneath,—several species of *Parus*, largely white-spotted,—while many of the pigeons have light ashy tints. The birds generally, however, have rich dark colours, similar to those which prevail among the butterflies.

In Celebes we have a swallow-shrike and a peculiar small crow allied to the jackdaw,[5] whiter than any of their allies in the surrounding islands, but otherwise the colours of the birds call for no special remark.

In Timor and Flores we have white-headed pigeons,[6] and a long-tailed flycatcher almost entirely white.[7]

In the small Lord Howe's Island we have the recently extinct white rail (*Notornis alba*), remarkably contrasting with its allies in the larger islands of New Zealand.

We cannot, however, lay any stress on isolated examples of white colour, since these occur in most of the great continents,

[1] *P. daunus*.

[2] *P. gundlachianus*, *P. villiersi*.

[3] *Pionus albifrons* and *Chrysotis senilis* (C. America), *Chrysotis sallæi* (Hayti).

[4] *Kittacincla albiventris*, *Geocichla albigularis*, *Sturnia andamanensis*, *Hyloterpe grisola*, var., *Janthænas palumboides*, *Osmotreron chloroptera*.

[5] *Artamus monachus*, *Corvus advena*.

[6] *Ptilopus cinctus*, *P. albocinctus*.

[7] *Tchitrea affinis*, var.

but where we find a series of species of distinct genera, all differing from their continental allies in a whiter colouration, as in the Andaman Islands and the West Indies; and among butterflies, in the smaller Moluccas, the Andamans, and Madagascar, we cannot avoid the conclusion that in these insular localities some general cause is at work.

There are other cases, however, in which local influences seem to favour the production or preservation of intense crimson or a very dark colouration. Thus in the Moluccas and New Guinea alone we have bright red parrots belonging to two distinct families,[1] and which, therefore, most probably have been independently produced or preserved by some common cause. Here too and in Australia we have black parrots and pigeons;[2] and it is a most curious and suggestive fact that in another insular sub-region—that of Madagascar and the Mascarene Islands—these same colours reappear in the same two groups.[3]

Some very curious physiological facts bearing upon the presence or absence of white colours in the higher animals have lately been adduced by Dr. Ogle.[4] It has been found that a coloured or dark pigment in the olfactory region of the nostrils is essential to perfect smell, and this pigment is rarely deficient except when the whole animal is pure white. In these cases the creature is almost without smell or taste. This, Dr. Ogle believes, explains the curious case of the pigs in Virginia adduced by Mr. Darwin, white pigs being poisoned by a poisonous root which does not affect black pigs. Mr. Darwin imputed this to a constitutional difference accompanying the dark colour, which rendered what was poisonous to the white-coloured animals quite innocuous to the black. Dr. Ogle however observes, that there is no proof that the black pigs eat the root, and he believes the more probable explanation to be that it is distasteful to them, while the white pigs, being deficient in smell and taste, eat it and are killed. Analogous facts occur in several distinct families. White sheep are killed in the Tarentino by eating *Hypericum crispum*, while black sheep escape; white rhinoceroses are said to perish from eating *Euphorbia candelabrum*; and white horses are said to suffer from poisonous food where coloured ones escape. Now it is very improbable that a constitutional immunity from poisoning by so many distinct plants should in the case of such widely different animals be always correlated with the same difference of colour; but the facts are readily understood if the senses of smell and taste are dependent on the presence of a pigment which is deficient in wholly white animals. The explanation has, however, been carried a step further, by experiments showing that the absorption of odours by dead matter, such as clothing, is greatly affected by colour, black being the most powerful absorbent, then blue, red, yellow, and lastly white. We have here a physical cause for the sense-inferiority of totally white animals which may account for their rarity in nature. For few, if any, wild animals are wholly white. The head, the face, or at least the muzzle or the nose, are generally black. The ears and eyes are also often black; and there is reason to believe that dark pigment is essential to good hearing, as it certainly is to perfect vision. We can therefore understand why white cats with blue eyes are so often deaf—a peculiarity we notice more readily than their deficiency of smell or taste.

If then the prevalence of white colouration is generally accompanied with some deficiency in the acuteness of the most important senses, this colour becomes doubly dangerous, for it not only renders its possessor more conspicuous to its enemies, but at the same time makes it less ready in detecting the presence of danger. Hence, perhaps, the reason why white appears more frequently in islands where competition is less severe and enemies less numerous and varied. Hence, also, a reason why *albinoism*, although freely occurring in captivity never maintains itself in a wild state, while *melanism* does. The peculiarity of some islands in having all their inhabitants of dusky colours—as the Galapagos—may also perhaps be explained on the same principles, for poisonous fruits or seeds may there abound which weed out all white or light-coloured varieties, owing to their deficiency of smell and taste. We can hardly believe, however, that this would apply to white-coloured butterflies, and this may be a reason why the effect of an insular habitat is more marked in these insects than in birds or mammals. But though inapplicable to the lower animals, this curious relation of sense-acuteness with colours may have had some influence on the development of the higher human races. If light tints of the skin were generally accompanied by some deficiency in the senses of smell, hearing, and vision, the white could never compete with the darker races, so long as man was in a very low or savage condition, and wholly dependent for existence on the acuteness of his senses. But as the mental faculties became more fully developed and more important to his welfare than mere sense-acuteness, the lighter tints of skin, and hair, and eyes, would cease to be disadvantageous whenever they were accompanied by superior brain-power. Such variations would then be preserved; and thus may have arisen the Xanthochroic race of mankind, in which we find a high development of intellect accompanied by a slight deficiency in the acuteness of the senses as compared with the darker forms.

I have now to ask your attention to a few remarks on the peculiar relations of plants and insects as exhibited in islands.

Ever since Mr. Darwin showed the immense importance of insects in the fertilization of flowers, great attention has been paid to the subject, and the relation of these two very different classes of natural objects has been found to be more universal and more complex than could have been anticipated. Whole genera and families of plants have been so modified, as first to attract and then to be fertilized by, certain groups of insects, and this special adaptation seems in many cases to have determined the more or less wide range of the plants in question. It is also known that some species of plants can be fertilized only by particular species of insects, and the absence of these from any locality would necessarily prevent the continued existence of the plant in that area. Here, I believe, will be found the clue to much of the peculiarity of the floras of oceanic islands, since the methods by which these have been stocked with plants and insects will be often quite different. Many seeds are, no doubt, carried by oceanic currents, others probably by aquatic birds. Mr. H. N. Moseley informs me that the albatrosses, gulls, puffins, tropic birds, and many others, nest inland, often amidst dense vegetation, and he believes they often carry seeds, attached to their feathers, from island to island for great distances. In the tropics they often nest on the mountains far inland, and may thus aid in the distribution even of mountain plants. Insects, on the other hand, are mostly conveyed by aerial currents, especially by violent gales; and it may thus often happen that totally unrelated plants and insects may be brought together, in which case the former must often perish for want of suitable insects to fertilise them. This will, I think, account for the strangely fragmentary nature of these insular floras, and the great differences that often exist between those which are situated in the same ocean, as well as for the preponderance of certain orders and genera. In Mr. Pickering's valuable work on the Geographical Distribution of Animals and Plants, he gives a list of no less than sixty-six natural orders of plants *unexpectedly* absent from Tahiti, or which occur in many of the surrounding lands, some being abundant in other islands—as the Labiatæ at the Sandwich Islands. In these latter islands the flora is much richer, yet a large number of families which abound in other parts of Polynesia are totally wanting. Now much of the poverty and exceptional distribution of the plants of these islands is probably due to the great scarcity of flower-frequenting insects. Lepidoptera and Hymenoptera are exceedingly scarce in the eastern islands of the Pacific, and it is almost certain that many plants which require these insects for their fertilization have been thereby prevented from establishing themselves. In the Western islands, such as the Fijis, several species of butterflies occur in tolerable abundance, and no doubt some flower-haunting Hymenoptera accompany them, and in these islands the flora appears to be much more varied, and especially to be characterized by a much greater variety of showy flowers, as may be seen by examining the plates of Dr. Seeman's "Flora Vitiensis."

Darwin and Pickering both speak of the great preponderance of ferns at Tahiti, and Mr. Moseley, who spent several days in the interior of the island, informs me that "at an elevation of from 2,000 to 3,000 feet the dense vegetation is composed almost entirely of ferns. A tree-fern (*Alsophila tahitensis*) forms a sort of forest, to the exclusion of almost every other tree, and, with huge plants of two other ferns (*Angiopteris evecta* and *Aspelenium nidus*), forms the main mass of the vegetation." And he adds, "I have nowhere seen ferns in so great proportionate abundance." This unusual proportion of ferns is a general feature of insular as compared with continental floras; but it has, I believe, been generally attributed to favourable conditions, especially to equable

1 *Lorius, Eos* Trichoglossidæ), *Eclectus* (Palæornithidæ).
2 *Microglossus, Calyptorhynchus, Turacæna.*
3 *Coracopsis, Alectrænas*
4 Medico-Chirurgical Transactions, vol. liii. (1870).

climate and perennial moisture. In this respect, however, Tahiti can hardly differ greatly from many other islands, which yet have no such vast preponderance of ferns. This is a question that cannot be decided by mere lists of species, since it is probable that in Tahiti they are less numerous than in some other islands where they form a far less conspicuous feature in the vegetation. The island most comparable with Tahiti in that respect is Juan Fernandez. Mr. Moseley writes to me—"In a general view of any wide stretch of the densely-clothed mountainous surface of the island, the ferns, both tree-ferns and the unstemmed forms, are seen at once to compose a very large proportion of the mass of foliage." As to the insects of Juan Fernandez, Mr. Edwyn C. Reed, who made two visits and spent several weeks there, has kindly furnished me with some exact information. Of butterflies there is only one (*Pyrameis carye*), and that rare—a Chilian species, and probably an accidental straggler. Four species of moths of moderate size were observed—all Chilian, and a few larvæ and pupæ. Of bees there were none, except one very minute species (allied to *Chilicola*), and of other Hymenoptera, a single specimen of *Ophion luteus*—a cosmopolitan ichneumon. About twenty species of flies were observed, and these formed the most prominent feature of the entomology of the island.

Now, as far as we know, this extreme entomological poverty agrees closely with that of Tahiti; and there are probably no other portions of the globe equally favoured in soil and climate and with an equally luxuriant vegetation, where insect-life is so scantily developed. It is curious therefore to find that these two islands also agree in the wonderful predominance of ferns over the flowering plants—in individuals even more than in species, and there is no difficulty in connecting the two facts. The excessive minuteness and great abundance of fern-spores causes them to be far more easily distributed by winds than the seeds of flowering plants, and they are thus always ready to occupy any vacant places in suitable localities, and to compete with the less vigorous flowering plants. But where insects are so scarce, all plants which require insect fertilisation, whether constantly to enable them to produce seed at all, or occasionally to keep up their constitutional vigour by crossing, must be at a great disadvantage; and thus the scanty flora which oceanic islands must always possess, peopled as they usually are by waifs and strays from other lands, is rendered still more scanty by the weeding out of all such as depend largely on insect fertilisation for their full development. It seems probable, therefore, that the preponderance of ferns in islands (considered in mass of individuals rather than in number of species) is largely due to the absence of competing phenogamous plants; and that this is in great part due to the scarcity of insects. In other oceanic islands, such as New Zealand and the Galapagos, where ferns, although tolerably abundant, form no such predominant feature in the vegetation, but where the scarcity of flower-haunting insects is almost equally marked, we find a great preponderance of small, green, or otherwise inconspicuous flowers, indicating that only such plants have been enabled to flourish there as are independent of insect fertilisation. In the Galapagos—which are perhaps even more deficient in flying insects than Juan Fernandez—this is so striking a feature that Mr. Darwin speaks of the vegetation as consisting in great part of "wretched-looking weeds," and states that "it was some time before he discovered that almost every plant was in flower at the time of his visit." He also says that he "did not see one beautiful flower" in the islands. It appears, however, that Compositæ, Leguminosæ, Rubiaceæ, and Solanaceæ, form a large proportion of the flowering plants, and as these are orders which usually require insect fertilisation, we must suppose either that they have become modified so as to be self-fertilised, or that they are fertilised by the visits of the minute Diptera and Hymenoptera, which are the only insects recorded from these islands.

In Juan Fernandez, on the other hand, there is no such total deficiency of showy flowers. I am informed by Mr. Moseley that a variety of the Magnoliaceous winter's bark abounds, and has showy white flowers, and that a Bignoniaceous shrub with abundance of dark blue flowers, was also plentiful; while a white-flowered liliaceous plant formed large patches on the hill-sides. Besides these there were two species of woody Compositæ with conspicuous heads of yellow blossoms, and a species of white-flowered myrtle also abundant; so that, on the whole, flowers formed a rather conspicuous feature in the aspect of the vegetation of Juan Fernandez.

But this fact—which at first sight seems entirely at variance with the view we are upholding of the important relation between the distribution of insects and plants—is well explained by the existence of two species of humming-birds in Juan Fernandez, which, in their visits to these large and showy flowers fertilise them as effectually as bees, moths, or butterflies. Mr. Moseley informs me that "these humming-birds are *extraordinarily abundant*, every tree or bush having one or two darting about it." He also observed that "nearly all the specimens killed had the feathers round the base of the bill and front of the head clogged and coloured yellow with pollen." Here, then, we have the clue to the perpetuation of large and showy flowers in Juan Fernandez; while the total absence of humming-birds in the Galapagos may explain why no such large-flowered plants have been able to establish themselves in those equatorial islands.

This leads to the observation that many other groups of birds also, no doubt, aid in the fertilization of flowers. I have often observed the beaks and faces of the brush-tongued lories of the Moluccas covered with pollen; and Mr. Moseley noted the same fact in a species of *Artamus*, or swallow-shrike, shot at Cape York, showing that this genus also frequents flowers and aids in their fertilisation. In the Australian region we have the immense group of the Meliphagidæ, which all frequent flowers, and as these range over all the islands of the Pacific, their presence will account for a certain proportion of showy flowers being found there, such as the scarlet *Metrosideros*, one of the few conspicuous flowers in Tahiti. In the Sandwich Islands, too, there are forests of *Metrosideros*; and Mr. Charles Pickering writes me, that they are visited by honey-sucking birds, one of which is captured by sweetened bird-lime, against which it thrusts its extensile tongue. I am also informed that a considerable number of flowers are occasionally fertilised by humming-birds in North America; so that there can, I think, be little doubt that birds play a much more important part in this respect than has hitherto been imagined. It is not improbable that in Tropical America, where this family is so enormously developed, many flowers will be found to be expressly adapted to fertilisation by them, just as so many in our own country are specially adapted to the visits of certain families or genera of insects.

It must also be remembered, as Mr. Moseley has suggested to me, that a flower which had acquired a brilliant colour to attract insects might, on transference to another country, and becoming so modified as to be capable of self-fertilisation, retain the coloured petals for an indefinite period. Such is probably the explanation of the *Pelargonium* of Kerguelen's land, which forms masses of bright colour near the shore during the flowering season; while most of the other plants of the island have colourless flowers in accordance with the almost total absence of winged insects. The presence of many large and showy flowers among the indigenous flora of St. Helena must be an example of a similar persistence. Mr. Melliss indeed states it to be "a remarkable peculiarity that the indigenous flowers are, with very slight exceptions, all perfectly colourless;"[1] but although this may apply to the general aspect of the remains of the indigenous flora, it is evidently not the case as regards the *species*, since the interesting plates of Mr. Melliss's volume show that about one-third of the indigenous flowering plants have more or less coloured or conspicuous flowers, while several of them are exceedingly showy and beautiful. Among these are a *Lobelia*, three *Wahlenbergias*, several *Compositæ*, and especially the handsome red flowers of the now almost extinct forest-trees, the ebony and redwood (species of *Melhania*, Byttneriaceæ). We have every reason to believe, however, that when St. Helena was covered with luxuriant forests, and especially at that remote period when it was much more extensive than it is now, it must have supported a certain number of indigenous birds and insects, which would have aided in the fertilisation of these gaily-coloured flowers. The researches of Dr. Hermann Muller have shown us by what minute modifications of structure or of function many flowers are adapted for partial insect- and self-fertilisation in varying degrees, so that we have no difficulty in understanding how, as the insects diminished and finally disappeared, self-fertilisation may have become the rule, while the large and showy corollas remain to tell us plainly of a once different state of things.

Another interesting fact in connection with this subject is the presence of arborescent forms of Compositæ in so many of the remotest oceanic islands. They occur in the Galapagos, in Juan Fernandez, in St. Helena, in the Sandwich Islands, and in New Zealand; but they are not directly related to each other, representatives of totally different tribes of this extensive order becoming arborescent in each group of islands. The immense range and almost universal distribution of the Compositæ is due to the combination of a great facility of distribution (by their seeds),

[1] Melliss's *St. Helena*, p. 226, note.

with a great attractiveness to insects, and the capacity of being fertilised by a variety of species of all orders, and especially by flies and small beetles. Thus they would be among the earliest of flowering plants to establish themselves on oceanic islands; but where insects of all kinds were very scarce it would be an advantage to gain increased size and longevity, so that fertilization at an interval of several years might suffice for the continuance of the species. The arborescent form would combine with increased longevity the advantage of increased size in the struggle for existence with the ferns and other early colonists, and these advantages have led to its being independently produced in so many distant localities, whose chief feature in common is their remoteness from continents and the extreme poverty of their insect life.

As the sweet odours of flowers are known to act in combination with their colours, as an attraction to insects, it might be anticipated that where colour was deficient scent would be so also. On applying to my friend Dr. Hooker for information as to New Zealand plants, he informed me that this was certainly the case, and that the New Zealand flora is, speaking generally, as strikingly deficient in sweet odours as in conspicuous colours. Whether this peculiarity occurs in other islands I have not been able to obtain information, but we may certainly expect it to be so in such a marked instance as that of the Galapagos flora.

Another question which here comes before us is the origin and meaning of the odoriferous glands of leaves. Dr. Hooker informed me that not only are New Zealand plants deficient in scented flowers, but equally so in scented leaves. This led me to think that perhaps such leaves were in some way an additional attraction to insects, though it is not easy to understand how this could be, except by adding a general attraction to the special attraction of the flowers, or by supporting the larvæ which as perfect insects aid in fertilisation. Mr. Darwin, however, informs me that he considers that leaf-glands bearing essential oils are a protection against the attacks of insects where these abound, and would thus not be required in countries where insects were very scarce. But it seems opposed to this view that highly aromatic plants are characteristic of deserts all over the world, and in such places insects are not abundant. Mr. Stainton informs me that the aromatic Labiatæ enjoy no immunity from insect attacks. The bitter leaves of the cherry-laurel are often eaten by the larvæ of moths that abound on our fruit-trees; while in the Tropics the leaves of the orange tribe are favourites with a large number of lepidopterous larvæ; and our northern firs and pines, although abounding in a highly aromatic resin, are very subject to the attacks of beetles. My friend Dr. Richard Spruce—who while travelling in South America allowed nothing connected with plant-life to escape his observation—informs me that trees whose leaves have aromatic and often resinous secretions in immersed glands abound in the plains of tropical America, and that such are in great part, if not wholly, free from the attacks of leaf-eating ants, except where the secretion is only slightly bitter, as in the orange tribe, orange-trees being sometimes entirely denuded of their leaves in a single night. Aromatic plants abound in the Andes up to about 13,000 feet, as well as in the plains, but hardly more so than in Central and Southern Europe. They are perhaps most plentiful in the dry mountainous parts of Southern Europe; and as neither here nor in the Andes do leaf-eating ants exist, Dr. Spruce infers that, although in the hot American forests where such ants swarm the oil-bearing glands serve as a protection, yet they were not originally acquired for that purpose. Near the limits of perpetual snow on the Andes such plants as occur are not, so far as Dr. Spruce has observed, aromatic: and as plants in such situations can hardly depend on insect visits for their fertilisation, the fact is comparable with that of the flora of New Zealand, and would seem to imply some relation between the two phenomena, though what it exactly is cannot yet be determined.

I trust I have now been able to show you that there are a number of curious problems lying as it were on the outskirts of biological inquiry which well merit attention, and which may lead to valuable results. But these problems are, as you see, for the most part connected with questions of locality, and require full and accurate knowledge of the productions of a number of small islands and other limited areas, and the means of comparing them the one with the other. To make such comparisons is, however, now quite impossible. No museum contains any fair representation of the productions of these localities, and such specimens as do exist, being scattered through the general collection, are almost useless for this special purpose. If, then, we are to make any progress in this inquiry, it is absolutely essential that some collectors should begin to arrange their cabinets primarily on a geographical basis, keeping together the productions of every island or group of islands, and of such divisions of each continent as are found to possess any special or characteristic fauna or flora. We shall then be sure to detect many unsuspected relations between the animals and plants of certain localities, and we shall become much better acquainted with those complex reactions between the vegetable and animal kingdoms, and between the organic world and the inorganic, which have almost certainly played an important part in determining many of the most conspicuous features of living things.

Rise and Progress of Modern Views as to the Antiquity and Origin of Man.

I now come to a branch of our subject which I would gladly have avoided touching on, but as the higher powers of this Association have decreed that I should preside over the Anthropological Department, it seems proper that I should devote some portion of my address to matters more immediately connected with the special study to which that Department is devoted.

As my own knowledge of, and interest in, Anthropology, is confined to the great outlines, rather than to the special details of the science, I propose to give a very brief and general sketch of the modern doctrine as to the Antiquity and Origin of Man, and to suggest certain points of difficulty which have not, I think, yet received sufficient attention.

Many now present remember the time (for it is little more than twenty years ago) when the antiquity of man, as now understood, was universally discredited. Not only theologians, but even geologists, then taught us that man belonged altogether to the existing state of things; that the extinct animals of the Tertiary period had finally disappeared, and that the earth's surface had assumed its present condition, before the human race first came into existence. So prepossessed were even scientific men with this idea—which yet rested on purely negative evidence, and could not be supported by any arguments of scientific value—that numerous facts which had been presented at intervals for half a century, all tending to prove the existence of man at very remote epochs, were silently ignored; and, more than this, the detailed statements of three distinct and careful observers were rejected by a great scientific Society as too improbable for publication, only because they proved (if they were true) the co-existence of man with extinct animals![1]

But this state of belief in opposition to facts could not long continue. In 1859 a few of our most eminent geologists examined for themselves into the alleged occurrence of flint implements in the gravels of the North of France, which had been made public fourteen years before, and found them strictly correct. The caverns of Devonshire were about the same time carefully examined by equally eminent observers, and were found fully to bear out the statements of those who had published their results eighteen years before. Flint implements began to be found in all suitable localities in the South of England, when carefully searched for, often in gravels of equal antiquity with those of France. Caverns, giving evidence of human occupation at various remote periods, were explored in Belgium and the South of France,—lake dwellings were examined in Switzerland—refuse heaps in Denmark—and thus a whole series of remains have been discovered carrying back the history of mankind from the earliest historic periods to a long distant past. The antiquity of the races thus discovered can only be generally determined by the successively earlier and earlier stages through which we can trace them. As we go back, metals soon disappear and we find only tools and weapons of stone and of bone. The stone weapons get ruder and ruder; pottery, and then the bone implements, cease to occur; and in the earliest stage we find only chipped flints, of rude design though still of unmistakably human workmanship. In like manner domestic animals disappear as we go backward; and though the dog seems to have been the earliest, it is doubtful whether the makers of the ruder flint implements of the gravels possessed even this. Still more important as a measure of time are the changes of the earth's surface—of the distribution of animals—and of climate—which have occurred during the human period. At a comparatively recent epoch in the record of prehistoric times we find that the Baltic was far salter than it is now, and produced abundance of oysters; and that Denmark

[1] In 1854 (?) a communication from the Torquay Natural History Society confirming previous accounts by Mr. Godwin-Austen, Mr. Vivian, and the Rev. Mr. McEnery, that worked flints occurred in Kent's Hole with remains of extinct species, was rejected as too improbable for publication.

was covered with pine forests inhabited by Capercailzies, such as now only occur further north in Norway. A little earlier we find that reindeer were common even in the South of France, and still earlier this animal was accompanied by the mammoth and woolly rhinoceros, by the arctic glutton, and by huge bears and lions of extinct species. The presence of such animals implies a change of climate, and both in the caves and gravels we find proofs of a much colder climate than now prevails in Western Europe. Still more remarkable are the changes of the earth's surface which have been effected during man's occupation of it. Many extensive valleys in England and France are believed by the best observers to have been deepened at least a hundred feet;—caverns now far out of the reach of any stream must for a long succession of years have had streams flowing through them, at least in times of floods—and this often implies that vast masses of solid rock have since been worn away. In Sardinia land has risen at least 300 feet since men lived there who made pottery and probably used fishing-nets;[1] while in Kent's Cavern remains of man are found buried beneath two separate beds of stalagmite, each having a distinct texture, and each covering a deposit of cave-earth having well-marked differential characters, while each contains a distinct assemblage of extinct animals.

Such, briefly, are the results of the evidence that has been rapidly accumulating for about fifteen years as to the antiquity of man; and it has been confirmed by so many discoveries of a like nature in all parts of the globe, and especially by the comparison of the tools and weapons of prehistoric man with those of modern savages, so that the use of even the rudest flint implements has become quite intelligible,—that we can hardly wonder at the vast revolution effected in public opinion. Not only is the belief in man's vast and still unknown antiquity universal among men of science, but it is hardly disputed by any well-informed theologian; and the present generation of science-students must, we should think, be somewhat puzzled to understand, what there was in the earliest discoveries that should have aroused such general opposition and been met with such universal incredulity.

But the question of the mere "Antiquity of Man" almost sank into insignificance at a very early period of the inquiry, in comparison with the far more momentous and more exciting problem of the development of man from some lower animal form, which the theories of Mr. Darwin and of Mr. Herbert Spencer soon showed to be inseparably bound up with it. This has been, and to some extent still is, the subject of fierce conflict; but the controversy as to the fact of such development is now almost at an end, since one of the most talented representatives of Catholic theology, and an anatomist of high standing —Professor Mivart—fully adopts it as regards physical structure, reserving his opposition for those parts of the theory, which would deduce man's whole intellectual and moral nature from the same source, and by a similar mode of development.

Never, perhaps, in the whole history of science or philosophy has so great a revolution in thought and opinion been effected as in the twelve years from 1859 to 1871, the respective dates of publication of Mr. Darwin's "Origin of Species" and "Descent of Man." Up to the commencement of this period the belief in the independent creation or origin of the species of animals and plants, and the very recent appearance of man upon the earth, were, practically, universal. Long before the end of it these two beliefs had utterly disappeared, not only in the scientific world, but almost equally so among the literary and educated classes generally. The belief in the independent origin of man held its ground somewhat longer, but the publication of Mr. Darwin's great work gave even that its death-blow, for hardly anyone capable of judging of the evidence now doubts the derivative nature of man's bodily structure as a whole, although many believe that his mind and even some of his physical characteristics may be due to the action of other forces than have acted in the case of the lower animals.

We need hardly be surprised, under these circumstances, if there has been a tendency among men of science to pass from one extreme to the other, from a profession (so few years ago) of total ignorance as to the mode of origin of all living things, to a claim to almost complete knowledge, of the whole progress of the universe, from the first speck of living protoplasm up to the highest development of the human intellect. Yet this is really what we have seen in the last sixteen years. Formerly difficulties were exaggerated, and it was asserted that we had not sufficient knowledge to venture on any generalizations on the subject. Now difficulties are set aside, and it is held that our theories are so well established and so far-reaching, that they explain and comprehend all nature. It is not long ago (as I have already reminded you) since *facts* were contemptuously ignored, because they favoured our now popular views; at the present day it seems to me that facts which oppose them hardly receive due consideration. And as opposition is the best incentive to progress, and it is not well even for the best theories to have it all their own way, I propose to direct your attention to a few such facts, and to the conclusions that seem fairly deducible from them.

It is a curious circumstance, that notwithstanding the attention that has been directed to the subject in every part of the world, and the numerous excavations connected with railways and mines which have offered such facilities for geological discovery, no advance whatever has been made for a considerable number of years, in detecting the time or the mode of man's origin. The Palæolithic flint weapons first discovered in the North of France more than thirty years ago, are still the oldest undisputed proofs of man's existence; and amid the countless relics of a former world that have been brought to light, no evidence of any one of the links that must have connected man with the lower animals has yet appeared.

It is, indeed, well known that negative evidence in geology is of very slender value, and this is, no doubt, generally the case. The circumstances here are, however, peculiar, for many converging lines of evidence show that on the theory of development by the same laws which have determined the development of the lower animals, man must be immensely older than any traces of him yet discovered. As this is a point of great interest we must devote a few moments to its consideration.

1. The most important difference between man and such of the lower animals as most nearly approach him, is undoubtedly in the bulk and development of his brain, as indicated by the form and capacity of the cranium. We should therefore anticipate that these earliest races, who were contemporary with the extinct animals and used rude stone weapons, would show a marked deficiency in this respect. Yet the oldest known crania—those of the Engis and Cro-Magnon caves— show no marks of degradation. The former does not present so low a type as that of most existing savages, but is—to use the words of Prof. Huxley —"a fair average human skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage." The latter are still more remarkable, being unusually large and well formed. Dr. Pruner-Bey states that they surpass the average of modern European skulls in capacity, while their symmetrical forms, without any trace of prognathism, compares favourably not only with the foremost savage races, but with many civilised nations of modern times.

One or two other crania of much lower type, but of less antiquity than this, have been discovered; but they in no way invalidate the conclusion which so highly developed a form at so early a period implies, viz., that we have as yet made a hardly perceptible step towards the discovery of any earlier stage in the development of man.

2. This conclusion is supported and enforced by the nature of many of the works of art found even in the oldest cave-dwellings. The flints are of the old chipped type, but they are formed into a large variety of tools and weapons—such as scrapers, awls, hammers, saws, lances, &c., implying a variety of purposes for which these were used, and a corresponding degree of mental activity and civilisation. Numerous articles of bone have also been found, including well-formed needles, implying that skins were sewn together, and perhaps even textile materials woven into cloth. Still more important are the numerous carvings and drawings representing a variety of animals, including horses, reindeer, and even a mammoth, executed with considerable skill on bone, reindeer-horns, and mammoth-tusks. These, taken together, indicate a state of civilisation much higher than that of the lowest of our modern savages, while it is quite compatible with a considerable degree of mental advancement, and leads us to believe that the crania of Engis and Cro-Magnon are not exceptional, but fairly represent the characters of the race. If we further remember that these people lived in Europe under the unfavourable conditions of a sub-Arctic climate, we shall be inclined to agree with Dr. Daniel Wilson, that it is far easier to produce evidences of deterioration than of progress in instituting a comparison between the contemporaries of the mammoth and later prehistoric races of Europe or savage nations of modern times.[2]

3. Yet another important line of evidence as to the extreme

[1] Lyell's Antiquity of Man, fourth edition, p. 115.

[2] "Prehistoric Man," 3rd ed. vol. i. p. 117.

antiquity of the human type has been brought prominently forward by Prof. Mivart.[1] He shows by a careful comparison of all parts of the structure of the body, that man is related, not to any one, but almost equally to many of the existing apes—to the orang, the chimpanzee, the gorilla, and even to the gibbons—in a variety of ways; and these relations and differences are so numerous and so diverse that on the theory of evolution the ancestral form which ultimately developed into man must have diverged from the common stock whence all these various forms and their extinct allies originated. But so far back as the Miocene deposits of Europe, we find the remains of apes allied to these various forms, and especially to the gibbons, so that in all probability the special line of variation which led up to man branched off at a still earlier period. And these early forms, being the initiation of a far higher type, and having to develop by natural selection into so specialised and altogether distinct a creature as man, must have risen at a very early period into the position of a dominant race, and spread in dense waves of population over all suitable portions of the great continent—for this, on Mr. Darwin's hypothesis, is essential to rapid developmental progress through the agency of natural selection.

Under these circumstances we might certainly expect to find some relics of these earlier forms of man along with those of animals which were presumably less abundant. Negative evidence of this kind is not very weighty, but still it has *some* value. It has been suggested that as apes are mostly tropical, and anthropoid apes are now confined almost exclusively to the vicinity of the equator, we should expect the ancestral forms also to have inhabited these same localities—West Africa and the Malay Islands. But this objection is hardly valid, because existing anthropoid apes are wholly dependent on a perennial supply of easily accessible fruits, which is only found near the equator, while not only had the south of Europe an almost tropical climate in Miocene times, but we must suppose even the earliest ancestors of man to have been terrestrial and omnivorous, since it must have taken ages of slow modification to have produced the perfectly erect form, the short arms, and the wholly non-prehensile foot, which so strongly differentiate man from the apes.

The conclusion which I think we must arrive at is, that if man has been developed from a common ancestor, with all existing apes, *and by no other agencies than such as have affected their development*, then he must have existed in something approaching his present form, during the tertiary period—and not merely existed, but predominated in numbers, wherever suitable conditions prevailed. If then, continued researches in all parts of Europe and Asia fail to bring to light any proofs of his presence, it will be at least a presumption that he came into existence at a much later date, and by a much more rapid process of development. In that case it will be a fair argument, that, just as he is in his mental and moral nature, his capacities and aspirations, so infinitely raised above the brutes, so his origin is due to distinct and higher agencies than such as have affected their development.

There is yet another line of inquiry bearing upon this subject to which I wish to call your attention. It is a somewhat curious fact, that, while all modern writers admit the great antiquity of man, most of them maintain the very recent development of his intellect, and will hardly contemplate the possibility of men equal in mental capacity to ourselves, having existed in prehistoric times. This question is generally assumed to be settled, by such relics as have been preserved of the manufactures of the older races showing a lower and lower state of the arts; by the successive disappearance in early times of iron, bronze, and pottery; and by the ruder forms of the older flint implements. The weakness of this argument has been well shown by Mr. Albert Mott in his very original, but little known presidential address to the Literary and Philosophical Society of Liverpool in 1873. He maintains that "our most distant glimpses of the past are still of a world peopled as now with men both civilised and savage"—and, "that we have often entirely misread the past by supposing that the outward signs of civilisation must always be the same, and must be such as are found among ourselves." In support of this view he adduces a variety of striking facts and ingenious arguments, a few of which I will briefly summarise.

On one of the most remote islands of the Pacific—Easter Island—2,000 miles from South America, 2,000 from the Marquesas, and more than 1,000 from the Gambier Islands, are found hundreds of gigantic stone images, now mostly in ruins, often thirty or forty feet high, while some seem to have been much larger, the crowns on their heads cut out of a red stone being sometimes ten feet in diameter, while even the head and neck of one is said to have been twenty feet high.[1] These once stood erect on extensive stone platforms, yet the island has only an area of about thirty square miles, or considerably less than Jersey. Now as one of the smallest images eight feet high weighs four tons, the largest must weigh over a hundred tons, if not much more; and the existence of such vast works implies a large population, abundance of food, and an established government. Yet how could these coexist in a mere speck of land wholly cut off from the rest of the world? Mr. Mott maintains that this necessarily implies the power of regular communication with larger islands or a continent, the arts of navigation, and a civilisation much higher than now exists in any part of the Pacific. Very similar remains in other islands scattered widely over the Pacific add weight to this argument.

The next example is that of the ancient mounds and earthworks of the North American continent, the bearing of which is even more significant. Over the greater part of the extensive Mississippi valley four well-marked classes of these earthworks occur. Some are camps, or works of defence, situated on bluffs, promontories, or isolated hills; others are vast inclosures in the plains and lowlands, often of geometric forms, and having attached to them roadways or avenues often miles in length; a third are mounds corresponding to our tumuli, often seventy to ninety feet high, and some of them covering acres of ground; while a fourth group consist of representations of various animals modelled in relief on a gigantic scale, and occurring chiefly in an area somewhat to the north-west of the other classes, in the plains of Wisconsin.

The first class—the camps or fortified inclosures—resemble in general features the ancient camps of our own islands, but far surpass them in extent. Fort Hill, in Ohio, is surrounded by a wall and ditch a mile and a half in length, part of the way cut through solid rock. Artificial reservoirs for water were made within it, while at one extremity, on a more elevated point, a keep is constructed with its separate defences and water-reservoirs. Another, called Clark's Work, in the Scioto valley, which seems to have been a fortified town, incloses an area of 127 acres, the embankments measuring three miles in length, and containing not less than three million cubic feet of earth. This area incloses numerous sacrificial mounds and symmetrical earthworks in which many interesting relics and works of art have been found.

The second class—the sacred inclosures—may be compared for extent and arrangement with Avebury or Carnak—but are in some respects even more remarkable. One of these, at Newark, Ohio, covers an area of several miles with its connected groups of circles, octagons, squares, ellipses, and avenues, on a grand scale, and formed by embankments from twenty to thirty feet in height. Other similar works occur in different parts of Ohio, and by accurate survey it is found not only that the circles are true, though some of them are one-third of a mile in diameter, but that other figures are truly square, each side being over 1,000 feet long, and what is still more important, the dimensions of some of these geometrical figures in different parts of the country and seventy miles apart, are identical. Now this proves the use, by the builders of these works, of some standard measures of length, while the accuracy of the squares, circles, and, in a less degree, of the octagonal figures—shows a considerable knowledge of rudimentary geometry, and some means of measuring angles. The difficulty of drawing such figures on a large scale is much greater than any one would imagine who has not tried it, and the accuracy of these is far beyond what is necessary to satisfy the eye. We must therefore impute to these people the wish to make these figures as accurate as possible, and this wish is a greater proof of habitual skill and intellectual advancement than even the ability to draw such figures. If, then, we take into account this ability and this love of geometric truth, and further consider the dense population and civil organisation implied by the construction of such extensive systematic works, we must allow that these people had reached the earlier stages of a civilisation of which no traces existed among the savage tribes who alone occupied the country when first visited by Europeans.

The animal mounds are of comparatively less importance for our present purpose, as they imply a somewhat lower grade of advancement; but the sepulchral and sacrificial mounds exist in vast numbers, and their partial exploration has yielded a quantity of articles and works of art, which throw some further light on the peculiarities of this mysterious people. Most of these mounds

[1] "Man and Apes," pp. 171-193.

[1] Journ. of Roy. Geog. Soc., 1870, pp. 177, 178.

contain a large concave hearth or basin of burnt clay, of perfectly symmetrical form, on which are found deposited more or less abundant relics, all bearing traces of the action of fire. We are, therefore, only acquainted with such articles as are practically fire-proof. These consist of bone and copper implements and ornaments, discs, and tubes—pearl, shell, and silver beads, more or less injured by the fire—ornaments cut in mica, ornamental pottery, and numbers of elaborate carvings in stone, mostly forming pipes for smoking. The metallic articles are all formed by hammering, but the execution is very good; plates of mica are found cut into scrolls and circles; the pottery, of which very few remains have been found, is far superior to that of any of the Indian tribes, since Dr. Wilson is of opinion that they must have been formed on a wheel, as they are often of uniform thickness throughout (sometimes not more than one-sixth of an inch) polished, and ornamented with scrolls and figures of birds and flowers in delicate relief. But the most instructive objects are the sculptured stone pipes, representing not only various easily recognisable animals, but also human heads, so well executed that they appear to be portraits. Among the animals, not only are such native forms as the panther, bear, otter, wolf, beaver, raccoon, heron, crow, turtle, frog, rattlesnake, and many others, well represented, but also the manatee, which perhaps then ascended the Mississippi as it now does the Amazon, and the toucan, which could hardly have been obtained nearer than Mexico. The sculptured heads are especially remarkable, because they present to us the features of an intellectual and civilised people. The nose in some is perfectly straight, and neither prominent nor dilated, the mouth is small, and the lips thin, the chin and upper lip are short, contrasting with the ponderous jaw of the modern Indian, while the cheek-bones present no marked prominence. Other examples have the nose somewhat projecting at the apex in a manner quite unlike the features of any American indigenes, and, although there are some which show a much coarser face, it is very difficult to see in any of them that close resemblance to the Indian type which these sculptures have been said to exhibit. The few authentic crania from the mounds present corresponding features, being far more symmetrical and better developed in the frontal region than those of any American tribes, although somewhat resembling them in the occipital outline;[1] while one was described by its discoverer (Mr. W. Marshall Anderson) as "a beautiful skull worthy of a Greek."

The antiquity of this remarkable race may perhaps not be very great, as compared with the prehistoric man of Europe, although the opinions of some writers on the subject seem affected by that "parsimony of time" on which the late Sir Charles Lyell so often dilated. The mounds are all overgrown with dense forest, and one of the large trees was estimated to be eight hundred years old, while other observers consider the forest growth to indicate an age of at least 1,000 years. But it is well known that it requires several generations of trees to pass away before the growth on a deserted clearing comes to correspond with that of the surrounding virgin forest, while this forest, once established, may go on growing for an unknown number of thousands of years. The 800 or 1,000 years estimate from the growth of existing vegetation is a minimum which has no bearing whatever on the actual age of these mounds, and we might almost as well attempt to determine the time of the glacial epoch from the age of the pines or oaks which now grow on the moraines.

The important thing for us, however, is that when North America was first settled by Europeans, the Indian tribes inhabiting it had no knowledge or tradition of any preceding race of higher civilisation than themselves. Yet we find that such a race existed; that they must have been populous and have lived under some established government; while there are signs that they practised agriculture largely, as indeed they must have done to have supported a population capable of executing such gigantic works in such vast profusion—for it is stated that the mounds and earthworks of various kinds in the state of Ohio alone amounts to between eleven and twelve thousand. In their habits, customs, religion, and arts, they differed strikingly from all the Indian tribes; while their love of art and of geometric forms, and their capacity for executing the latter upon so gigantic a scale, render it probable that they were a really civilised people, although the form their civilisation took may have been very different from that of later people subject to very different influences, and the inheritors of a longer series of ancestral civilisations. We have here, at all events, a striking example of the transition, over an extensive country, from comparative civilisation to comparative barbarism, the former having left no tradition, and hardly any trace of influence on the latter.

[1] Wilson's "Prehistoric Man," 3rd ed. vol. ii. pp. 123-130.

As Mr. Mott well remarks:—Nothing can be more striking than the fact that Easter Island and North America both give the same testimony as to the origin of the savage life found in them, although in all circumstances and surroundings the two cases are so different. If no stone monuments had been constructed in Easter Island, or mounds, containing a few relics saved from fire, in the United States, we might never have suspected the existence of these ancient peoples. He argues, therefore, that it is very easy for the records of an ancient nation's life entirely to perish, or to be hidden from observation. Even the arts of Nineveh and Babylon were unknown only a generation ago, and we have only just discovered the facts about the mound-builders of North America.

But other parts of the American continent exhibit parallel phenomena. Recent investigations show that in Mexico, Central America, and Peru, the existing race of Indians has been preceded by a distinct and more civilised race. This is proved by the sculptures of the ruined cities of Central America, by the more ancient terra-cottas and paintings of Mexico, and by the oldest portrait-pottery of Peru. All alike show markedly non-Indian features, while they often closely resemble modern European types. Ancient crania, too, have been found in all these countries, presenting very different characters from those of any of the modern indigenous races of America.[1]

There is one other striking example of a higher being succeeded by a lower degree of knowledge, which is in danger of being forgotten because it has been made the foundation of theories which seem wild and fantastic, and are probably in great part erroneous. I allude to the Great Pyramid of Egypt, whose form, dimensions, structure, and uses have recently been the subject of elaborate works by Prof. Piazzi Smyth. Now, the admitted facts about this pyramid are so interesting and so apposite to the subject we are considering, that I beg to recall them to your attention. Most of you are aware that this pyramid has been carefully explored and measured by successive Egyptologists, and that the dimensions have lately become capable of more accurate determination owing to the discovery of some of the original casing-stones and the clearing away of the earth from the corners of the foundation, showing the sockets in which the corner-stones fitted. Prof. Smyth devoted many months of work with the best instruments in order to fix the dimensions and angles of all accessible parts of the structure; and he has carefully determined these by a comparison of his own and all previous measures, the best of which agree pretty closely with each other. The results arrived at are—

1. That the pyramid is truly square, the sides being equal and the angles right angles.

2. That the four sockets on which the four first stones of the corners rested are truly on the same level.

3. That the direction of the sides are accurately to the four cardinal points.

4. That the vertical height of the pyramid bears the same proportion to its circumference at the base, as the radius of a circle does to its circumference.

Now all these measures, angles, and levels are accurate, not as an ordinary surveyor or builder could make them, but to such a degree as requires the very best modern instruments and all the refinements of geodetical science to discover any error at all. In addition to this we have the wonderful perfection of the workmanship in the interior of the pyramid, the passages and chambers being lined with huge blocks of stones fitted with the utmost accuracy, while every part of the building exhibits the highest structural science.

In all these respects this largest pyramid surpasses every other in Egypt. Yet it is universally admitted to be the oldest, and also the oldest historical building in the world.

Now these admitted facts about the Great Pyramid are surely remarkable, and worthy of the deepest consideration. They are facts which, in the pregnant words of the late Sir John Herschel, "according to received theories ought not to happen," and which, he tells us, should therefore be kept ever present to our minds, since "they belong to the class of facts which serve as the clue to new discoveries." According to modern theories, the higher civilisation is ever a growth and an outcome from a preceding lower state; and it is inferred that this progress is visible to us throughout all history and in all the material records of human intellect. But here we have a building which marks the

[1] Wilson's "Prehistoric Man," 3rd ed. vol. ii. pp. 125, 144.

very dawn of history—which is the oldest authentic monument of man's genius and skill, and which, instead of being far inferior, is very much superior to all which followed it. Great men are the products of their age and country, and the designer and constructors of this wonderful monument could never have arisen among an unintellectual and half-barbarous people. So perfect a work implies many preceding less perfect works which have disappeared. It marks the culminating point of an ancient civilisation, of the early stages of which we have no record whatever.

The three cases to which I have now adverted (and there are many others) seem to require for their satisfactory interpretation a somewhat different view of human progress from that which is now generally accepted. Taken in connection with the great intellectual power of the ancient Greeks—which Mr. Galton believes to have been far above that of the average of any modern nation—and the elevation, at once intellectual and moral, displayed in the writings of Confucius, Zoroaster, and the Vedas, they point to the conclusion, that, while in material progress there has been a tolerably steady advance, man's intellectual and moral development reached almost its highest level in a very remote past. The lower, the more animal, but often the more energetic types, have however always been far the more numerous; hence such established societies as have here and there arisen under the guidance of higher minds, have always been liable to be swept away by the incursions of barbarians. Thus in almost every part of the globe there may have been a long succession of partial civilisation, each in turn succeeded by a period of barbarism; and this view seems supported by the occurrence of degraded types of skull along with such "as might have belonged to a philosopher"—at a time when the mammoth and the reindeer inhabited southern France.

Nor need we fear that there is not time enough for the rise and decay of so many successive civilisations as this view would imply; for the opinion is now gaining ground among geologists that palæolithic man was really preglacial, and that the great gap—marked alike by a change of physical conditions, and of animal life—which in Europe always separates him from his neolithic successor, was caused by the coming on and passing away of the great ice age.

If the views now advanced are correct, many, perhaps most, of our existing savages, are the successors of higher races; and their arts, often showing a wonderful similarity in distant continents, may have been derived from a common source among more civilised peoples.

I must now conclude this very imperfect sketch of a few of the offshoots from the great tree of Biological study. It will, perhaps, be thought by some that my remarks have tended to the depreciation of our science, by hinting at imperfections in our knowledge and errors in our theories, where more enthusiastic students see nothing but established truths. But I trust that I may have conveyed to many of my hearers a different impression. I have endeavoured to show that even in what are usually considered the more trivial and superficial characters presented by natural objects, a whole field of new inquiry is opened up to us by the study of distribution and local conditions. And as regards man, I have endeavoured to fix your attention on a class of facts which indicate that the course of his development has been far less direct and simple than has hitherto been supposed; and that, instead of resembling a single tide with its advancing and receding ripples, it must rather be compared to the progress from neap to spring tides, both the rise and the depression being comparatively greater as the waters of true civilisation slowly advance towards the highest level they can reach.

And if we are thus led to believe that our present knowledge of nature is somewhat less complete than we have been accustomed to consider it, this is only what we might expect; for however great may have been the intellectual triumphs of the nineteenth century, we can hardly think so highly of its achievements as to imagine that, in somewhat less than twenty years, we have passed from complete ignorance to almost perfect knowledge on two such vast and complex subjects as the origin of species and the antiquity of man.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY F. J. EVANS, C.B., F.R.S., CAPTAIN R.N., PRESIDENT.

Two events, notable in the annals of Geographical Science have to be recorded since the last meeting of the British Association; and these events as bearing materially on the advancement of our knowledge of geography are deserving the special commendation of this Section. I refer to the successful issue of Cameron's land journey across the tropical regions of Southern Africa and to the successful completion of the sea voyage of the *Challenger*; a voyage which in its scope included the circumnavigation of the globe, the traversing the several oceans between the 50th parallel of North latitude and the Antarctic circle, and the exploration throughout, by the medium of the sounding line and dredge, of the contour features, the formation, and the animal life of the great oceanic bed.

The general results of the notable African land journey have already, through our parent society in London, been brought largely under public review; and at our present meeting many details of interest will be placed before you by the intrepid traveller himself. The courage, perseverance and patient attention to the records of this long travel have been dwelt on by our highest geographical authorities, and so far it might appear superfluous to join in praise from this chair; nevertheless, it is to that part of the proceedings of Cameron, the unvarying attention and care he bestowed on instrumental observations, in order to give those proceedings a secure scientific basis, to which I would direct your attention as being of a high order of merit.

With this example before us, remembering the country and climate in which such unremitting labours were carried out, distinction to the future explorer cannot rest on the mere rendering of estimated topographical details, but can alone be fully merited when those details are verified by instrumental observations of an order sufficient to place numerically before geographers the physical features and characteristics of the explored region.

Turning now from the results of the land journey of Cameron to those of the sea voyage of the *Challenger* we are again reminded of the value of repeated and methodically arranged instrumental observations in geographical research. With our present knowledge of the sea-board regions of the globe, little remains, except in Polar areas, for the navigator to do in the field of discovery, or even of exploration, otherwise than in those details rendered necessary by the requirements of trade or special industries. It is to the development of the scientific features of geography that the attention of voyagers requires to be now mainly directed; and in this there is an illimitable field. The great advance in this direction resulting from the two leading events of the past year, to which I have referred, foreshadows geographical research of the future.

Communications of special value from some of those voyagers whose good fortune it was to leave and return to their native land in the ship *Challenger* will doubtless be made to this and other Sections. I trust nevertheless, as one officially interested in the expedition from its inception, and as having in early days been engaged in kindred work, and also as I hope without being considered to have trespassed on the scientific territories of these gentlemen ground indeed so well earned,—this meeting will view with indulgence my having selected as the leading theme of my address to it, a review of that branch of our science now commonly known as the "Physical Geography of the Sea;" combined with such suggestive matter as has presented itself to me whilst engaged in following up the proceedings of this remarkable voyage.

It has been well observed that "contact with the ocean has unquestionally exercised a beneficial influence on the cultivation of the intellect and formation of the character of many nations, on the multiplication of those bonds which should unite the whole human race, on the first knowledge of the true form of the earth and on the pursuit of astronomy and of all the mathematical and physical sciences." The subject is thus not an ignoble one, and further, it appears to me appropriate, assembled as we are in the commercial metropolis of Scotland, from among whose citizens some of the most valuable scientific investigations bearing on the art of navigation have proceeded.

As a prefatory remark, I would observe that the distinctive appellation "Physical Geography of the Sea" is due to the accomplished geographer Humboldt; it is somewhat indefinite though comprehensive, and implies that branches of science not strictly pertaining to geography, as commonly understood, are invaded; but this intrusion or overlapping of scientific boundaries is inevitable with the expansion of knowledge: and it is difficult to see how the term can be wisely amended, or how the several included branches of physics can be separated from pure geographical science.

We are indebted in our generation to the genius and untiring

energy of Maury, aided originally by the liberal support of his Government, for placing before us in the two-fold interests of science and commerce an abundant store of observed facts in this field; accompanied, too, by those broad generalisations, which, written with a ready pen and the fervour of an enthusiast gifted with a poetic temperament, have charmed so many readers, and in their practical bearings have undoubtedly advanced navigation in practice.

In our admiration, however, of modern progress we must not in justice pass by without recognition the labours of earlier workers in the same field. So early as the middle of the seventeenth century we find in Holland, Barnard Vanerius describing with commendable accuracy the direction of the greater currents of the Atlantic Ocean and their dependence on prevailing winds; the unequal saltness of the sea, the diversity of temperature as the causes of the direction of the winds, and also speculating on the depths of the sea. Vanerius's geographical writings were highly appreciated by Newton, and editions were prepared at Cambridge under the supervision of that great man in 1672 and 1681.

To Dampier the seaman, and Halley the philosopher, we owe graphic descriptions of the trade winds as derived from personal experience; while the investigations by Hadley of their causes, and the conclusions he arrived at, that they were due to the combined effects of the diurnal revolution of the earth on its axis, and the unequal distribution of heat over different parts of the earth's surface, in substance still remain unchallenged.

To Rennell we owe a masterly investigation of the currents of the Atlantic Ocean, an investigation, which for precision and a thorough conception of the conditions affecting the subject will long serve as a model for imitation. His period covered some thirty or forty years during the end of the last and the beginning of the present century. At that epoch, chronometers—though very efficient—had scarcely passed the stage of trial, but had nevertheless commended themselves to the first navigators of the day, whose aim it was to narrowly watch and test this, to them, marvellous acquisition. Rennell thus commanded nautical observations of a high order of merit; these he individually verified, both for determining the ship's position absolutely and relatively to the course pursued; and our knowledge of surface-currents was established on the secure basis of differential results obtained at short intervals, such as a day or parts of a day, instead of the previous rude estimation from a ship's reckoning extending over a whole voyage, or its greater part.

At a later date we have by Redfield, Reed, Thom, and others, solidly practical investigations of the gyratory and at the same time bodily progressive movements of those fierce and violent storms which, generated in tropical zones, traverse extensive districts of the ocean, not unfrequently devastating the narrow belt of land comprised in their track; and on the sea baffling all the care and skill of the seaman to preserve his ship scathless; while the clear and elegant exposition by Dove of their law and its application as one common general principle to the ordinary movements of the atmosphere must commend itself as one of the achievements of modern science.

While for the moment in the aerial regions, we must not forget the industry and scientific penetration of the present excellent secretary of the Scottish Meteorological Society. His more recent development of the several areas of barometric pressure, both oceanic and continental, bids fair to amend and enlarge our conceptions of the circulation of both the aerial and liquid coverings of our planet.

Looking then from our immediate stand-point on the extent of our knowledge, as confirmed by observational facts of the several branches of physics pertaining to the geography of the sea, just rapidly reviewed, we find that, resulting from the methodical gathering up of "ocean statistics" by our own and other maritime nations, in the manner shadowed forth by Maury and stamped by the Brussels Conference of 1853, we are in possession of a goodly array of broad but nevertheless sound results. The average seasonal limits of the trade winds and monsoons, with the areas traversed by circular storms are known; also the general linear direction and varying rates of motion of the several ocean currents and streams; together with the diffused values of air and sea surface temperatures, the areas of uniform barometric pressure, and the prevalent winds, over the navigable parts of the globe.

Thus far the practical advantages that have accrued to the art of navigation—and so directly aiding commerce—by the gradual diffusion of this knowledge through the medium of graphical rendering on charts, and concise textual descriptions, cannot be over-rated; still much is wanting in fulness and precision of detail, especially in those distant but limited regions more recently opened out by expanding trade. Science views, too, with increasing interest these advances in our knowledge of ocean physics, as bearing materially on the grand economy of nature: essays brilliant and almost exhaustive on some of its subjects, have been given to us by eminent men of our own day; but here one is reminded, by the diversity in the rendering of facts, how much remains to be done in their correlation, and what an extensive and still expanding field is before us.

The dawning efforts of science to pass beyond the immediate practical requirements of the navigator are worthy of note. We find—from an admirable paper on the "Temperatures of the Sea at different Depths," by Mr. Prestwich, just published in the *Philosophical Transactions*—that in the middle of last century the subject of deep-sea temperatures first began to attract attention, and thermometers for the purpose were devised; but it was not till the early part of the present century that the curiosity of seamen appears to have been generally awakened to know more of the ocean than could be gleaned on its surface. John Ross, when in the Arctic seas in 1818, caught glimpses of animal life at the depth of 6,000 feet; other navigators succeeded in obtaining the temperature of successive layers of water to depths exceeding 6,000 feet, but, so far as I can ascertain, James Ross was, in 1840, the first to record beyond doubt that bottom had been reached, "deeper than did ever plummet sound," at 16,060 feet, westward of the Cape of Good Hope.

The impetus to deep sea exploration was, however, given by the demand for electric telegraphic communication between countries severed by the ocean, or by impracticable land routes, and the past twenty years marks its steady growth. Appliances for reaching the bottom with celerity, for bringing up its water, for bringing up its formation, for registering its thermal condition *in situ*, have steadily improved, and thus the several oceans were examined both over present and prospective telegraph routes. Science, aroused by the consideration that vast fields for biological research were opening up—as proved by the returns, prolific with living and dead animal matter, rendered by the comparatively puny appliances originally used for bringing up the sea bottom—invoked, as beyond the reach of private enterprise, the aid of Government. Wisely, earnestly, and munificently was the appeal responded to, and thus the *Challenger* Expedition has become the culminating effort of our own day.

We have now reached, in all probability, a new starting-point in reference to many of our conceptions of the physics of the globe, and our own special branch may not be the least affected. There is opened up to us, for example, as fair a general knowledge of the depression of the bed of large oceanic areas below the sea level, as of the elevation of the lands of adjacent continents above that universal zero line. We learn for the first time by the *Challenger's* results—ably supplemented as they have recently been by the action of the U.S. Government in the Pacific, and by an admirable series of soundings made in the exploratory German ship of war *Gazelle*—that the unbroken range of ocean in the southern hemisphere is much shallower than the northern seas, that it has no features approaching in character those grand abyssal depths of 27,000 and 23,500 feet found respectively in the North Pacific and North Atlantic Oceans, as the greatest reliable depths recorded do not exceed 17,000 or 17,500 feet.

The general surface of the sea bed presents in general to the eye, when graphically rendered on charts by contour lines of equal soundings, extensive plateaux varied with the gentlest of undulations. There is diversity of feature in the western Pacific Ocean, where, in the large area occupied by the many groups of coral islands, their intervening seas are cut up into deep basins or hollows, some 15,000, some 20,000 feet deep. In the Northern Oceans one is struck with the fact that the profounder depths in the Pacific occupy a relative place in that ocean with those found in the Atlantic; both abyssal areas have this, too, in common, the maximum depths are near the land, the sea surface temperature has the maximum degree of heat in either ocean, and two of the most remarkable ocean streams—Florida Gulf and Japan—partially encompass them.

In the Atlantic Ocean, from a high Southern latitude, a broad channel with not less than some 12,000 to 15,000 feet can be traced, as extending nearly to the entrance of Davis Strait: a dividing undulating ridge of far less depression, on which stand the islands of Tristan d'Acunha, St. Helena, and Ascension, separates this which may be named the Western Channel from a

similar one running parallel to the South African Continent, and which extends to the parallel of the British Islands. It is possible that certain tidal and, indeed, climatic conditions, peculiar to the shores of the North Atlantic, may be traced to this bottom conformation, which carries its deep, canal-like character into Davis Strait, and between Greenland, Iceland, and Spitzbergen, certainly to the 80th parallel.

There is, however, one great feature common to all oceans, and which may have some significance in the consideration of ocean circulation, and as affecting the genesis and translation of the great tidal wave and other tidal phenomena, of which we know so little; namely, that the fringe of the seaboard of the great continents and islands, from the depth of a few hundred feet below the sea-level, is, as a rule, abruptly precipitous to depths of 10,000 and 12,000 feet. This grand escarpment is typically illustrated at the entrance of the British Channel, where the distance between a depth of 600 feet and 12,000 feet is in places only ten miles. Imagination can scarcely realise the stupendous marginal features of this common surface depression.

Vast in extent as are these depressed regions—for we must recollect that they occupy an area three times greater than the dry land of the globe, and that a temperature just above the freezing-point of Fahrenheit prevails in the dense liquid layers covering them—life is sustained even in the most depressed and coldest parts; while in those areas equivalent in depression below the sea-level to that of European Alpine regions above it, animal life abundantly prevails: structural forms complicated in arrangement, elegant in appearance, and often lively in colour, clothe extensive districts; other regions apparently form the sepulchral resting-place of organisms which when living existed near the surface; their skeletons, as it has been graphically put, thus, "raining down in one continuous shower through the intervening miles of sea-water." Geological formations, stamped with the permanency of ages, common to us denizens of the dry land, appear, in these regions, to be in course of evolution; forces involving the formation of mineral concretions on a grand scale are at work; life is abundant everywhere in the surface and subsurface waters of the oceans; in fine, life and death, reproduction and decay, are active, in whatever depths have been attained.

As a question of surpassing interest in the great scheme of nature, the economy of ocean circulation, affecting as it does the climatic conditions of countries, has of late attracted attention. The general facts of this circulation in relation to climate have been thus tersely summarised: "Cold climates follow polar waters towards the equator, warm climates follow warm equatorial streams towards the poles." We can all appreciate the geniality of our own climate, especially on the western shores of the kingdom, as compared with the Arctic climate of the shores of Labrador, situated on the same parallels of latitude; or indeed, with the vigorous winter climate of the adjacent North American seaboard, even ten degrees farther to the south. These, and kindred features in other parts of the globe, have led to the summarised generalisation I have just referred to, but the *rationale* of these movements of the waters is by no means assured to us.

That ocean currents were due primarily to the trade and other prevailing winds, was the received opinion from the earliest investigation made by navigators of the constant surface movement of the sea. Rennell's views are thus clearly stated—"The winds are to be regarded as the prime movers of the currents of the ocean, and of this agency the *trade winds* and *monsoons* have by far the greatest share, not only in operating on the *larger half* of the whole extent of the circumambient ocean, but as possessing greater power by their constancy and elevation to generate and perpetuate currents" . . . "next to these, in degrees, are the *most prevalent* winds, such as the westerly wind beyond, or to the north and south, of the region of trade winds."

Maury, so far as I am aware, was the first to record his dissent from these generally received views of surface currents being due to the impulse of the winds, and assigned to differences of specific gravity, combined with the earth's rotation on its axis, the movement of the Gulf Stream, and other well defined ocean currents.

A writer of the present time, gifted with high inductive reasoning powers and with observed facts before him in wide extension of those investigated by Rennell, regards the various ocean currents as members of one grand system of circulation; not produced by the trade winds alone, nor by the prevailing winds proper alone, but by the continued action of all the prevailing winds of the globe regarded as one system of circulation; and that without exception, he finds the direction of the main currents of the globe to agree exactly with the direction of the prevailing winds.

Another writer of the present day, distinguished for intellectual power, and who personally has devoted much time to the acquisition of exact physical facts bearing on the question both in the ocean near our own shores and in the Mediterranean sea, without denying the agency of the winds, so far as surface drifts are concerned, considers that general ocean circulation is dependent on thermal agency alone; resulting in the movement of a deep stratum of polar waters to the equator, and the movement of an upper stratum from the equator towards the poles: the "disturbance of hydrostatic equilibrium" being produced by the increase of density occasioned by polar cold and the reduction of density occasioned by equatorial heat; and that polar cold rather than equatorial heat is the *primum mobile* of the circulation. Analogous views had also been entertained by Continental physicists from sea temperature results obtained in Russian and French voyages of research in the early part of this century.

We have here presented to us two distinct conceptions of ocean circulation—the one to a great extent confined to the surface and horizontal in its movements, the other vertical extending from the ocean surface to its bed, and involving, as a consequence, "that every drop of water will thus [except in confined seas] be brought up from its greatest depths to the surface."

With these several hypotheses before us, it may be fairly considered that the problem of "ocean circulation" is still unsolved. Possibly, the real solution may require the consideration of physical causes beyond those which have been hitherto accepted. In attempting the solution, it appears to me impossible to deny that the agency of the winds is most active in bringing about great movements on the surface waters: the effects of the opposite monsoons in the India and China seas furnishing corroborative proof. Again, the remarkable thermal condition of the lower stratum of the water in enclosed seas, as the Mediterranean, and in those basin-like areas of the Western Pacific cut off by encircling submarine ridges from the sources of polar supplies, combined with the equally remarkable conditions of cold water from a polar source flowing side by side or interlacing with warm water from equatorial regions—as in the action of the Labrador and Gulf Streams—points to the hypothesis of a vertical circulation as also commanding respect.

The time may be considered, however, to have now arrived for gathering up the many threads of information at our disposal; and by fresh combinations to enlarge at least our conceptions, even if we fail in satisfying all the conditions of solution. To this task I will briefly address myself.

A grand feature in terrestrial physics, and one which I apprehend bears directly on the subject before us, is that producing ice movement in Antarctic seas. We know from the experience gained in ships—which, to shorten the passages to and from this country, Australia and New Zealand, have followed the great circle route, and thus attained high southern latitudes—that vast tracts of ice from time to time become disrupted from the fringe of southern lands. Reliable accounts have reached us of vessels frequently running down several degrees of longitude, sadly hampered by meeting islands of ice; and especially of one ship being constantly surrounded with icebergs in the corresponding latitudes to those of London and Liverpool, extending nearly the whole distance between the meridians of New Zealand and Cape Horn. Indeed, accumulated records point to the conclusion that on the whole circumference of the globe south of the 50th parallel, icebergs, scattered more or less, may be constantly fallen in with during the southern summer.

The Antarctic voyages of D'Urville, Wilkes, and James Ross assure us of the origin and character of these ice masses which dot the Southern seas. Each of these voyagers were opposed in their progress southward—D'Urville and Wilkes on the 65th parallel, Ross on the 77th, by barrier cliffs of ice. Ross traced this barrier 250 miles in one unbroken line; he describes it as one continuous perpendicular wall of ice, 200 to 100 feet high above the sea, with an unvarying level outline, and probably more than 1,000 feet thick—"a mighty and wonderful object." Ross did not consider this ice barrier as resting on the ground, for there were soundings in 2,500 feet a few miles from the cliffs; Wilkes also sounded in over 5,000 feet, only a short distance from the barrier.

There is singular accord in the descriptive accounts by Wilkes and Ross of this ice region; they both dwell on the difference in

character of Antarctic from Arctic ice formation, on the tabular form of the upper surface of the floating icebergs, and their striated appearance; on the extreme severity of the climate in midsummer; of the low barometric pressure experienced—and express equal wonderment at the stupendous forces necessary to break away the face of these vast ice barriers, and the atmospheric causes necessary for their reproduction.

From the drift of this disrupted ice we have fair evidence of a great bodily movement of the waters northward; for it must be remembered that icebergs have been fallen in with in the entire circumference of the southern seas, and that they are pushed in the South Atlantic Ocean as far as the 40th parallel of latitude; in the South Indian to the 45th parallel; and in the South Pacific to the 50th parallel.

In the discussion of ocean circulation, it has been assumed that water flows from Equatorial into Antarctic areas; there is no evidence, so far as I am aware, that warm surface water in the sense implied is found south of the 55th parallel. Surface stream movement northward and eastward appears to be that generally experienced in the zone between the Antarctic circle and that parallel. With then, this great bodily movement northward of Antarctic waters included certainly between the surface and the base, or nearly so, of these tabular icebergs (and thus representing a stratum certainly some thousand feet in thickness), the question arises, How and from whence does the supply come to fill the created void? Sir Wyville Thomson, the leader of the *Challenger* scientific staff, in one of the later of the many able reports he has forwarded to the Admiralty, furnishes, I think, a reasonable answer. Stating first his views as derived from study of the bottom temperature of the Pacific Ocean generally, he writes:—"We can scarcely doubt that, like the similar mass of cold bottom-water in the Atlantic, the bottom-water of the Pacific is an extremely slow indraught from the Southern Sea." He then gives the reason. "I am every day more fully satisfied that this inflow of cold water into the Pacific and Atlantic Oceans from the southward is to be referred to the simplest and most obvious of all causes, the excess of evaporation over precipitation of the land-hemisphere; and the excess of precipitation over evaporation in the middle and southern parts of the water-hemisphere."

Before following up the great northward movement of Antarctic waters, I would draw attention to a physical feature in connection with tidal movements, which possibly may be one of the many links in the chain of causes affecting ocean circulation. The mean tide level (or that imaginary point equidistant from the high and low water-marks as observed throughout a whole lunation) has been assumed as an invariable quantity; our Ordnance Survey adopts it as the zero from whence all elevations are given: the *datum level* for Great Britain being the level of mean tide at Liverpool. For practical purposes, at least on our own shores, this mean sea-level may be considered invariable, although recent investigations of the tides at Liverpool and Ramsgate indicate changes in it to the extent of a few inches, and which changes are embraced in an annual period, attaining the maximum height in the later months of the year; these have been assumed as possibly due to meteorological rather than to the astronomical causes involved by tidal theory.

From an examination of some tidal observations recently made near the mouth of Swan River, in Western Australia, during the progress of the Admiralty survey of that coast, there appears to me evidence that in this locality open, it will be remembered, to the wide southern seas—the sea-level varies appreciably during the year: thus, the greatest daily tidal range in any month very rarely exceeds 3 feet, but the high and low water-marks range during the year 5 feet. The higher level is attained in June, and exceeds the lower level, which is reached in November, by one foot or more. At Esquimalt in Vancouver Island, fairly open to the North Pacific Ocean, there are indications of the sea-level being higher in January than it is in June; and a distinct excess of the mean level of the tide by several inches in December and January, as compared with the summer months, was traced by the late Captain Beechy, R.N., at Holyhead (see *Phil. Trans.* 1848). If this surface oscillation is a general oceanic feature, and some further proofs indirectly appear in the Reports of the Tidal Committee to this Association for 1868, '70, '72, to which I have just referred—for mention is also made of a large annual tide of over three inches, reaching its maximum in August, having been observed at Cat Island, in the Gulf of Mexico;—we may have to recognise this physical condition, that the waters of the southern hemisphere attain a high level at the period of the year when the sun is to the north of the equator, and that the northern waters are highest at the period when the sun is to the south of the equator. This is a question of so much interest that I propose again to revert to it.

Variations in the sea level have been observed, notably in the central parts of the Red Sea, where the surface water, as shown by the exposure of coral reefs, is said to be fully two feet lower in the summer months than in the opposite season; these differences of level are commonly assigned to the action of the winds.

Rennell, in his "Investigation of the Currents of the Atlantic Ocean," states, on what would appear reliable authority, that on the African Guinea coast the level of the sea is higher by at least six feet perpendicular in the season of the strong S.W. and southerly winds—which winds blow obliquely into the Bay of Benin between April and September, the rainy season also—than during the more serene weather of the opposite season; the proof being that the tides ebb and flow regularly in the several rivers during the period of strong S.W. winds, but that in the other season the same rivers run ebb constantly, the level of the sea being then too low to allow the tide waters to enter the mouths of the rivers. It is possible the cause, here and elsewhere, may, in part be cosmical, and neither meteorological nor astronomical in a tidal sense.

These several facts in relation to the variations in levels of the surface of the ocean are interesting, and point to new fields of observation and research.

Another physical feature connected with the ocean level is deserving consideration; I refer to the effect of the pressure of the atmosphere. On good authority we know that the height of high water in the English Channel varies inversely as the height of the barometer; the late Sir John Lubbock laid it down as a rule that a rise of one inch in the barometer causes a depression in the height of high water amounting to seven inches at London and to eleven inches at Liverpool. Sir James Ross when at Port Leopold, in the Arctic seas, found that a difference of pressure of ·668 of an inch in the barometer produced a difference of 9 inches in the mean level of the sea, the greatest pressure corresponding to the lowest level. These results appeared to him to indicate "that the ocean is a water-barometer on a vast scale of magnificence, and that the level of its surface is disturbed by every variation of atmospheric pressure inversely as the mercury in the barometer, and exactly in the ratio of the relative specific gravities of the water and the mercury." When we consider the exceptionally low barometric pressure prevailing in the southern seas, and the comparatively low pressure of the Equatorial Ocean zones as compared with the areas of high pressure in the oceans north and south of the Equator—the latter features a late development by Mr. Buchan—these characteristic conditions of atmospheric pressures cannot exist without presumably affecting the surface conditions of adjacent waters.

There is yet one more point in connection with the ocean circulation which I venture to think has not received the attention it demands; this is the economy of those currents known as "counter equatorial." Their limits are now fairly ascertained, and are found to be confined to a narrow zone; they run in a direction directly opposite to, and yet side by side with, the equatorial streams of both the Atlantic and Pacific Oceans. We know that they run at times with great velocity (the *Challenger* experienced fifty miles in a day in the Pacific Ocean), and occasionally in the face of the trade wind; and that they are not merely local, stretching as they do across the wide extent of the Pacific; and in the Atlantic, during the summer months of our hemisphere, extending nearly across from the Guinea Coast to the West India Islands. They have too this significant feature that their narrow zone is confined to the *northern side alone* of the great west-going equatorial currents; this zone is approximately between the parallels of 7° and 10° N., and thus corresponds with the belt of greatest atmospherical heat on the earth's surface.

That the functions of the counter currents in the physics of the ocean are important must, I think, be conceded. They appear to act on their eastern limits as feeders to the equatorial currents; and from the seasonal expansion, which has been well traced in the Atlantic, are probably more immediately associated with some oscillatory movement of the waters following, though perhaps only remotely connected with, the sun's movements in declination.

A brief summary of the thermal conditions of the oceanic basins will now enable us to review the salient features of ocean circulation, and the more immediate scientific position the question has assumed.

In all seas within the torrid and temperate zones, provided any given area is not cut off by submarine barriers from a supply of polar or glacial water, the sea bed is covered by a thick stratum of water, the temperature of which is confined between 32° and 35° F. In the Pacific Ocean this cold stratum must be derived from Antarctic sources, for the opening of Behring Strait is too small to admit of an appreciable efflux of Arctic waters. In this ocean the cold stratum obtains generally at depths below 9,000 feet from the surface, with an almost invariable isothermal line of 40° F., at from 2,500 to 3,000 feet from the surface. Similarly, in the Indian Ocean basin, the cold stratum at the bottom is derived from Antarctic sources, for the temperature of 33°·5 F. underlies the hot surface waters of the Arabian Gulf.

In the South Atlantic, Antarctic waters, with a bottom temperature of 31° to 33°·5 F., certainly cross the equator; the bed of the North Atlantic basin then warms up to 35°—marked diversities in both the temperatures and thickness of the successive layers of water from the surface downwards are found—and in the central parts of the basin it is not until the vicinity of the Faroe Islands is reached that Arctic waters of an equivalent temperature to those from Antarctic sources are experienced.

Turning now to the scientific aspect of the question:—

The doctrine of a general oceanic thermal circulation assumes two general propositions—1, the existence of a deep under-flow of glacial water from each pole to the equator; and 2, the movement of the upper stratum of oceanic water from the equatorial region towards each pole, as the necessary complement of the deep polar under-flow—this double movement being dependent "upon the disturbance of hydrostatic equilibrium constantly maintained by polar cold and equatorial heat."

Proposition 2, in its general application as to the movement of surface waters, is unquestionable; but that of a deep under-flow from the poles, as a necessary complement, remains open to doubt. Proposition 1, in its wide generality, must, from what we know of the Pacific, be confined to the Atlantic Ocean; and it appears to me that it is on the interpretation of the movement of the waters in its northern basin that the hypothesis of a vertical circulation and the potency of thermal agency in bringing it about must be judged.

We have followed the movements of Antarctic waters in the Atlantic to the 40th parallel, as illustrated by the progress of icebergs; we know that the movement deflects the strong Agulhas current, and that the cold waters well up on the western shore of the South African continent, cooling the equatorial current near its presumed source; the thrusting power of this body of water is therefore great. About the equator it rises comparatively near to the surface. But we now come to another and distinct movement—the equatorial current—and on this, I apprehend, the material agency of the winds cannot be denied, in forcing an enormous mass of surface-water from east to west across the ocean. The Gulf Stream results, and the comparative powers of this stream, as especially influencing the climate of our own and neighbouring countries, together with the forces at work to propel its warm waters across the Atlantic, has become the controversial field for the upholders of horizontal and vertical circulation. The one hypothesis assigns to the Gulf Stream all the beneficent powers of its genial warmth—extending even beyond the North Cape of Europe—which has been conceded to it from the time of Franklin. The other hypothesis reduces its capacity and power, considers that it is disintegrated in mid-Atlantic, and that the modified climate we enjoy is brought by prevailing winds from the warm area surrounding the stream; and to this has been more recently added, "by the heating power of a warm sub-surface stratum, whose slow northward movement arises from a constantly renewed disturbance of thermal equilibrium between the polar and equatorial portions of the oceanic area."

Without denying the active powers of this disturbed thermal equilibrium—although in this special case it is an abstraction difficult to follow—and giving due weight to the many cogent facts which have been brought forward in support of both views, there appears to be still a connecting link or links wanting to account for the southern movements of Arctic waters; which movements to me are even more remarkable as physical phenomena than the translation of the warm waters from the Gulf Stream area to a high northern latitude.

This movement of Arctic waters is forcibly illustrated by the winter drifts down Davis Strait of the ships *Resolute*, *Fox*, *Advance*, and part of the crew of the *Polaris*, when enclosed in pack ice, exceeding in some cases a thousand miles; similarly of the winter drift of a part of the German expedition of 1870 down the east side of Greenland, from the latitude of 72° to Cape Farewell. If to these examples we add the experience of Parry in his memorable attempt to reach the North Pole from Spitzbergen in the summer of 1827, it must be inferred that a perennial flow of surface water from the polar area into the Atlantic obtains; and, judging from the strength of the winter northerly winds, that the outflow is probably at its maximum strength in the early months of the year.

When we further know that the northern movement of warm waters gives *in winter* a large accession of temperature to the west coast of Scotland, to the Faroe Islands, and extending to the coasts of Norway as far as the North Cape; the consideration arises whether this onward movement of waters from southern sources is not the immediate cause of displacement of th water in the polar area, and its forced return along the channels indicated by those winter drifts to which I have referred.

That some hitherto unlooked-for and unsuspected cause is the great agent in forcing southern waters into the Atlantic polar basin has long forced itself on my conviction, and I now suspect it is to the cause producing the annual variations in the sea level—for, as I have mentioned, indications exist of the seas of the northern hemisphere having a higher level in winter than in summer,—that we must direct our attention before the full solution of ocean circulation is accepted.

The facts of the annual changes of sea level, whatever they may ultimately prove, have hitherto ranged themselves as a part of tidal action, and so escaped general attention. Physicists well know the complication of tidal phenomena, and if one may be permitted to say, the imperfection of our tidal theory; certain it is that the tides on the European coasts of the Atlantic are so far abnormal that one of our best authorities on the subject (Sir William Thomson) describes them, in relation, I assume, to tidal theory, as "irregularly simple," while the tides in all other seas are comparatively complicated, but "regular and explicable." However this may be, specialists should direct their attention to the disentanglement of the variations in the sea level from tidal action simple; and our colonies, especially those in the southern hemisphere, would be excellent fields for the gathering in of reliable observations.

I am unwilling to leave the subject without tracing some of the consequences that might be fairly considered to follow this assumed change of level in the North Atlantic basin. We can by it conceive the gradual working up of the warmed water from southern sources as the winter season approaches, including the expansion of the Gulf Stream in the autumn months; the consequent welling up of a head of water in the enclosed and comparatively limited area northward of Spitzbergen, Greenland, and the broken land westward of Smith Sound; the forced return of these glacial waters, their greatest volume seeking the most direct course, and thus working down the Labrador coast, charged with ice, and passing the American coast inside the Gulf Stream; while the smaller volume, reaching the higher latitudes in mid-Atlantic, interlaces with the warm barrier waters, causing those alternating bands of cold and warm areas familiar to us from the *Lightning* and *Porcupine* observations, and which are now being worked out by the Norwegian exploring expedition in the government ship *Voringen*.

We can further conceive that the larger function of the "counter currents" on the north margin of the great equatorial streams is to act as conduits for the surcharged waters of the Northern Oceans consequent on the gradual changes of level. The Atlantic counter-current we know expands markedly in the autumnal season, and there may be some connection between this expansion and the high level of the waters said to exist in the Gold Coast and Guinea bights at the same season.

We are thus, as it appears to me, now only on the threshold of a large field of inquiry bearing on the physical geography of the sea; but we have this advantage,—the admirable discussions which have taken place in the past few years, productive as they have been of the marshalling hosts of valuable facts, will lighten the labours of those who engage in its prosecution. Science is deeply indebted to, and I am sure honours, those who have so earnestly worked on the opening pages of the coming chapter on Ocean Circulation.

Unwillingly I turn from this interesting subject; but the demands on my time and your patience are imperative: as, following precedent, it is incumbent on me briefly to bring under the review of the Association the latest unrecorded incidents in geographical progress or research.

There is one absorbing topic which, in the course of a few

weeks, or even days, may attract general interest. I refer to accounts of our Arctic expedition. It is possible that while I am now addressing you, the ships *Alert* and *Discovery*, favoured by fine seasons, may have, in their endeavours to reach high northern latitudes, accomplished all that human skill and energy can do, and by fortuitous circumstances secured their return southward through Smith Sound, with the same facilities, as we have reason to hope, they entered what we suppose to be that notable gateway to the Pole. If so, they are now fairly in Davis Strait, homeward bound. We must not regard this estimate of progress as visionary, for, the conditions being favourable, the time at the disposal of the voyagers is ample. It is the varying conditions of Arctic seasons, we must remember, that baffle the forecasts of the most experienced Arctic experts.

Should unfavourable conditions, or the decision of the chief, detain the ships another year in their icy quarters, we have reason to hope that advices will reach us of their whereabouts in the spring of next year. The spirited enterprise of the well-trained Arctic navigator, Allan Young, supported as he has been by the Government, offers a sure guarantee that the leaders, Nares and Stephenson, will be ably seconded in their efforts to keep up communication with their countrymen. Here, again, we must not forget that baffling conditions may defeat the intentions of the commanders to communicate in time with the depots at the portals of Smith Sound.

This prolonged banishment from intercourse with the outer world was, however, a contingency anticipated and provided for by that able Committee of Arctic Officers who, with a full sense of their responsibility, so fully advised the Government in every phase of this national undertaking. A parliamentary paper, published during this session, gives the fullest particulars relating to the progress of the expedition and the steps which have been taken to communicate with their depôts. There is a long chain of contingencies to be attended to, as will be seen on reference to the interesting details therein given, but I venture to think that not a link is missing, either in the conception, or in the means provided to bring the undertaking to a successful issue.

There is one feature to be kept in view, which from the exceptional conditions of ship navigation in the icy regions of the far north is rarely realized, unless by those who have had actual experience in polar service, and it is this, that between the time of the disruption of the old ice in August and the formation of the new in September, there exists a very short period when ships are free to move. This period of open or partially open water may be shortened by unfavourable circumstances, and *vice versâ*; it may be assumed, however, that in a straight fairway channel such as Smith Sound it almost always does occur, and as the return southward, on account of the drift, is always more easily accomplished than the advance north, the great probability is that, if the ships remain out another year, it will be the result of design rather than accident.

By the parliamentary papers relating to the expedition it will be seen that, in the event of the non-arrival of the *Alert* and *Discovery* during the autumn of this year, a relief ship will be despatched to a rendezvous in Smith Sound during the summer of 1877.

With regard to Africa, exploration and discovery have proceeded with accelerated strides during the past few years. Even since the recent date of Cameron's remarkable journey across the continent, important additions have been made to the rapidly filling-up map of the interior. Most of these additions relate to the great lakes, regarding which our knowledge was previously very incomplete and unsatisfactory. Thus, Mr. Young, the experienced Zambesi traveller, who undertook last year to lead the Scotch Missionary party to Lake Nyassa, has succeeded, after establishing the missionary settlement "Livingstonia," at the southern end of the lake, in reaching in a steam-launch the northern end of this great fresh-water sea, finding it to be fully one hundred miles longer than was previously believed. His journey was made in February of the present year, and in the following month the still more imperfectly known lake, Albert Nyanza, was successfully navigated by two boats under Signor Gessi, who was despatched for this purpose by Colonel Gordon, the present Governor of the new Equatorial Province of the Khedive's dominions. The details of Signor Gessi's interesting exploration, communicated by himself to the President of the Royal Geographical Society, have only recently reached England, and it is proposed to read them in the course of the present meeting.

A third, and equally important exploration of the same class is that performed during the same early months of the present year by that energetic traveller Mr. Stanley. After circumnavigating the much larger neighbouring lake, Victoria, and proving Speke's much disputed estimate of its dimensions to be approximately correct, he pushed his way across the difficult tract of country separating the Victoria and the Albert lakes, reaching the shores of the latter in the middle of January. Less fortunately situated than Signor Gessi, who embarked on the lake two months later, Stanley was unable to launch his boat on the then unexplored southern portions of its waters. A comparison of the accounts of the two travellers shows that we are yet far from knowing the true dimensions of this great sheet of water. Signor Gessi in fact did not reach its southern extremity; and as Mr. Stanley appears to have struck its shores at a point about thirty miles further south than the limits marked by the Italian traveller, the lake must be considerably longer than 140 miles, as estimated by the latter. Stanley subsequently proceeded south and explored the Kitangulé river of Speke; thence striking for Lake Tanganyika, the examination of which he intended to complete.

New Guinea has of late attracted some attention both at home and in the Australian colonies; rather, however, from political than geographical considerations. Our interest is of course in the latter, and I am glad the meeting will have the advantage of the presence of a gentleman, Mr. Octavius Stone, recently arrived in England, who has distinguished himself in the exploration of the south-eastern shores of this distant, little known, and barbarous region; to him we must refer for the latest geographical facts.

OUR ASTRONOMICAL COLUMN

THE CORDOBA "URANOMETRIA."—Dr. Gould has informed us, during his flying visit to this country in the last week, on his return to Cordoba from the United States, that he intends to give his *Uranometria* first and undivided attention, with the view to its early publication. It contains 8,000 stars to seventh magnitude inclusive, the whole estimated by not less than two observers, and often by more, each observer making his determination on not less than two nights, and often more, all cases of discordance between different observers being subsequently examined. The greater number of the stars have been observed with the meridian circle, and always in cases of doubt as to identification. The magnitudes are intended to be given to o·1m by comparisons with previously established standards, on a most carefully-considered system. The manuscript charts are drawn to the scale of a globe of one *metre* radius, and the magnitudes of the stars are represented by dots of size proportional to the brilliancy to nearest two-tenths of a magnitude. Though this part of the work appears to have been completed to Dr. Gould's entire satisfaction, he expresses himself much disturbed as to the means of reproducing these manuscript charts with the necessary accuracy and delicacy; his hopes of success from the use of photography having been thus far disappointed. The *Uranometria* will include every star to the seventh magnitude inclusive, from the south pole of the heavens to ten degrees of north declination. Great care has been taken to secure accurate delineation of the course of the Milky Way and of the Magellanic Clouds.

The Zones, another most important work to which attention has been directed at Cordoba, are complete; they are 754 in number, and contain 105,000 stars.

In addition, materials have been obtained for the formation of a numerous catalogue of the brighter stars, each one observed several times with the meridian circle.

Dr. Gould is to be congratulated on the extraordinary energy he has displayed in his management of the new Observatory of the Argentine Republic, and the discriminating skill with which he has selected and worked his subjects of observation, which must undoubtedly result in his leaving a name lastingly associated with the astronomy of the southern hemisphere; and not less is the Government of that comparatively new country to be honoured for the constant and unstinted support they have afforded

to their national Observatory, and its distinguished and indefatigable director.

AN INTRA-MERCURIAL PLANET (?).—At the sitting of the Paris Academy of Sciences on the 28th ultimo, M. Leverrier announced that he had received a letter from Prof. Rudolf Wolf, of Zurich, in which it was stated that three observers situated in three different places had witnessed, on April 4, the passage of a round spot over the sun's disc. The three localities were—in Germany (near Münster), Greece (Athens), and Switzerland (Zurich). The date is subsequent to the observation of Dr. Lescarbault by 6,219 days, which figure is the product of 148 into 42·02 (printed 40·02 in *L'Institut*, whence this notice is taken), and it may be conjectured that, if the object were a planet, it had made this number of revolutions of 42·02 days.

Such a body would have a mean distance from the sun equal to 0·2365 of the earth's mean distance, with a maximum elongation in a nearly circular orbit of about 13½ degrees, the period of revolution being almost precisely half that of Mercury.

We await details of the observations before examining how far the date 1876, April 4, can be made to agree with similar ones already upon record, supposing all to refer to a single body revolving under the conditions named.

NEW MINOR PLANET.—The *Bulletin International* of the Paris Observatory notifies the discovery of No. 167, by Prof. Peters, at Clinton, U.S., on August 28. R.A. $21^h. 57^m.$, N.P.D., $101^\circ 30'$, motion south, twelfth magnitude.

NOTES

WE notice, with extreme regret, the announcement of the death of Mr. George Smith, of the British Museum, the accomplished Assyriologist. A telegram received on Monday at the British Museum from Constantinople stated that Mr. Smith died at Aleppo, on the 19th ult., and that further particulars would be ultimately sent. Faint hopes are entertained that the sad announcement will be contradicted. The Turkish Government and officials had thrown so many difficulties in his way that Mr. Smith was on his road home in disgust. It will be remembered that he started in February last on his third archæological expedition to the East. The high value of Mr. Smith's work in a department of research of great importance has been universally acknowledged, and it will be difficult to over-estimate his loss to science and to the British Museum. He has earned an enduring place in the important domain of Eastern archæology.

MR. HOWARD GRUBB, of Dublin, has presented to the Scientific Committee appointed to superintend the work, his Report on the Progress of the Great Equatorial for the Vienna Observatory, the contract for which was concluded in June last year with the Austro-Hungarian Government. The work, we are glad to say, has gone on smoothly and successfully. To enable him to carry on his important undertaking Mr. Grubb has constructed a spacious dodecagon chamber, forty-two feet in internal diameter, the roof of which is so constructed as to allow the great steel dome to be erected over it. Mr. Grubb had contracted with Feil of Paris for the supply of the discs of glass for the great objective, and the flint disc is already in Dublin, where it is now undergoing a rigid examination. The crown disc M. Feil expects to have ready in a few weeks; meanwhile active preparations are being made for the grinding and polishing of the objective. Parts of the general framing have been cast; the polar pillar is completely finished; the polar axis has had most of its parts adjusted. The cross-head and declination axis are completely finished, and the declination circle and adapter nearly so. The clockwork and many of the other parts of the elaborate apparatus necessary for the working of the telescope are also complete, and Mr. Grubb is preparing a travelling gantry across the observatory, and proposes commencing shortly to put together the general ramework and erect the larger portions of the mounting. A communication from Prof. Newcomb has induced Mr. Grubb to take means to obviate the temporary spherical aberration in the objective produced by the difference of temperature outside and inside the tube. Altogether Mr. Grubb is to be congratulated on the progress he is making in his great undertaking. From the *Deutsche Zeitung* we learn that the new observatory itself is making rapid progress towards completion, and may be ready by the beginning of winter, though it will take two or three years to complete the internal arrangements. The telescope, a refractor with a 26-inch objective and 30 feet focal distance, is expected to be ready by the autumn of 1878.

ALGOLOGISTS will be glad to hear that Prof. Agardh of Lund, Sweden, has just published a new volume (vol. iii.) of his work entitled "Species, Genera, et Ordines Algarum." (Epicrisis Systematis Floridearum. Auctore, J. G. Agardh. Lipsiæ: apud T. O. Weigel, 1876.) In it he treats of the Florideæ only; the whole of which, with the exception of the orders *Corallineæ* and *Rhodomeleæ*, are included in it. The Florideæ, it will be remembered, formed the subject of the second volume of "Species Algarum." Since it was published immense numbers of Algæ, in excellent condition, have been submitted to scientific observation; many new species and genera have been added to the list of marine plants; old observations have been verified or corrected; unexpected affinities between plants supposed to be far apart in the system of classification; or discrepancies, equally unexpected, between plants supposed to be closely allied, have been perceived. Improved methods of study have led to the discovery of former errors of classification and description; and the necessity has long been felt by algologists of a work, the arrangement of which should be more in accordance with the present state of knowledge, and in which old errors should be corrected, and new forms described. Such a work Prof. Agardh has now given us, and we are sure it will meet with a welcome reception. The present classification is based on a thorough examination of the internal structure of the frond and of the fruit; and the Professor tells us that no species has been admitted into the text which he had not previously examined. Species, which in the former work had been accurately described, are merely referred to in the present, which must therefore be considered supplementary, and as in no wise superseding the former volume. The present work contains upwards of 700 pages 8vo.

AMONG the questions down for discussion at the Social Science Congress to be held in October, 11th to 18th, at Liverpool, are the following:—In the Education Section—What methods are best adapted to secure the efficient Training of Teachers of all grades, especially in the art of teaching? How can the due connection between Secondary (Grammar) Schools, Elementary Schools, and the Universities, by means of exhibitions, scholarships, or otherwise, be most effectually maintained? How can Professional and Technical Instruction be best incorporated with a sound system of general education? In the Health Section—What is the best mode of making provision for the Supply and Storage of Water—(*a*) in large towns such as Liverpool and Manchester; (*b*) in groups of urban communities of lesser size, such as exist in the manufacturing districts of Lancashire and Yorkshire? What amendments are required in the legislation necessary to prevent the evils arising from Noxious Vapours and Smoke?

AT Pesth, on Monday, the International Prehistoric Congress was opened in presence of the Archduke Joseph, by Herr Trefort, the Minister of Public Instruction, who welcomed the

guests on behalf of the Hungarian Government. The President of the Congress, Herr Pulszky, then gave an address, in which he enlarged on the prehistoric periods of Hungary. The secretary also read an address treating on the development of prehistoric studies in Hungary, and commenting on the fine collection of prehistoric articles now exhibited. There are over one hundred foreign guests of all nations. Among them are Mr. Franks, of the British Museum; M. Broca, delegated by the French Government; Signor Pigorini, by the Italian Government; and Herr Virchow, of Berlin.

MR. WILLETT has published his fourth and final Report to the British Association on the Sub-Wealden Exploration. After giving a brief history of the enterprise, he states that he resigned the hon. secretaryship on May 1, when Major Beaumont, M.P., chairman of the Diamond Boring Company, offered to take his place and raise funds to continue the work, which had been carried to 1,894 feet. Mr. Willett then says:—"Four months have elapsed. No committee have been summoned. No fresh funds have been raised, and, in my opinion, it is quite time that the whole affair be wound up, and that the exploration be finally abandoned in this locality." His reasons for this conclusion we shall give when his Report comes up at the British Association meeting.

LETTERS received from Baron A. von Hügel announce his arrival in Fiji, where he has already made considerable collections of birds. A full account of his work in New Zealand, with details of his future plans, has unfortunately been lost in transmission to England, but it would appear that he still intends to visit some more of the Pacific Islands, and perhaps New Guinea, before commencing his work in Western Australia. The investigation of the natural history of the latter country was his principal object on leaving England.

THE Iron and Steel Institute commences its autumn meeting at Leeds on the 18th inst.

IT has been observed by M. Jeannel that certain sonorous vibrations cause rotatory movement in the radiometer. In half obscurity, three radiometers were placed on the interior tablet of a chamber organ. The bass notes, those of the three first octaves, produced rotation, the most bass acting most, but *fa* and *fa* sharp of the lower octave (especially with the bourdon stop) produced more rapid rotation than *ut*, *re*, and *mi*, though these are more grave. Radiometers do not all act in the same manner, as to rapidity and direction of their rotation. Thus, to the low *fa* or *fa* sharp radiometer A, the less sensitive to light, made about one turn per second. The black faces first (*i.e.* a direction opposite to that produced by light), whilst radiometers B and C, which were more sensitive to light, turned more slowly and in the direction of the movement produced by light. M. Jeannel explains these effects by circular or angular vibrations of the supporting needle transmitted from the tablet of the organ. By applying the finger to the top of the radiometer, one may prevent the vibration and also the rotation. The board of a piano produces similar effects, but in less degree. If the experiments indicated be made where the diffuse light is nearly sufficient to drive the radiometer, grave sounds, even the weakest, cause rotation in the ordinary direction (bright surfaces first); the rumble of a vehicle will suffice. Here the light is at first insufficient to overcome the friction, but when the vibrations intervene, friction is lessened during certain intervals, and the apparatus is thus rendered more sensitive to light.

M. FRON has given, in the *Bulletin International* of Aug. 12, a short note of the thunderstorms in France on June 9, 1875, on which day they occurred in forty-three departments. The barometric depression accompanying this remarkable development of thunderstorms amounted to 0·630 inch at Valentia, 0·472 inch in Brittany, and 0·276 inch at Paris. An illustration is given showing that the barometer fell to its lowest point at Paris at the time the thunderstorm broke over the city, and that at the same time in the centre of this depression the barometer suddenly rose and as suddenly fell through about 0·033 inch, the whole of this brief-continued oscillation occupying less than an hour. It would be a valuable piece of work if the French meteorologists could, from an examination of the changes in the direction and force of the wind, the aqueous precipitation, the electrical and other meteorological phenomena which occurred at the time, trace this singular barometric fluctuation to its physical causes.

THE number of visitors to the Loan Collection of Scientific Apparatus during the week ending Sept. 2 was as follows:—Monday, 3,200; Tuesday, 2,977; Wednesday, 468; Thursday, 355; Friday, 332; Saturday, 3,925; total, 11,257.

À propos of the meeting of the British Association, *Science Gossip* for September contains an interesting article on the Geology of Glasgow and the neighbourhood, by Mr. R. L. Jack, F.G.S., of the Geological Survey.

THE first number of *The Mineralogical Magazine and Journal of the Mineralogical Society of Great Britain and Ireland* has just been issued. It contains eight papers on subjects of mineralogical interest. Lake and Lake of Truro are the publishers.

THE General Meteorological Council of the Gironde have passed a resolution asking the French Government to establish the Meteorological Service on the basis adopted in the United States; other general councils will do the same, and the result will very likely be an increase in the sums voted for the meteorological service.

M. WADDINGTON has published a circular organising an improved system for obtaining school statistics in France. The number of pupils admitted into primary schools has been, up to the present time, determined merely by the names of children inscribed on the school register, though the attendance of many is merely nominal. The roll will be called henceforth twice a-day, morning and afternoon, so that the real state of things may be known, and no compliment paid to national pride.

THE Municipal Council of Perpignan voted, at its last sitting, a sum of 15,000 francs for the purpose of erecting a statue to François Arago, who was born in the department of Pyrenées Orientales, of which Perpignan is the chief town. His native place was Estagel, a small village, where a monument has already been erected to him.

THE City of Grenoble inaugurated, on August 14, a statue in honour of Vaulanson, a celebrated mechanician born there in the beginning of the eighteenth century.

THE programmes for admission to the newly-created French National School of Agriculture have been officially published. The examination will take place very shortly, and the first promotions will be announced in the beginning of next year. The ex-imperial Vincennes farm has been devoted to the new establishment, which, besides those who have passed examinations, will admit a number of pupils free. No charge will be made for education.

AFTER repeated efforts an agricultural experimental station in Connecticut was successfully established, under the charge of the trustees of the Wesleyan University. The preliminary report of less than half a year's labours has just been published, and shows the enterprise to have been a legitimate one in view of the amount and character of the work accomplished. The establishment is in charge of Prof. W. O. Atwater, an agricultural chemist of eminence, under whose direction a considerable number of analyses of fertilisers have been made. The result of the labours of this experimental station has already been to define with precision the percentage of nitrogen to the ton in the

various fertilisers offered for sale, and the withdrawal from the market of several worthless articles.

M. Duruof the aeronaut made an ascent at Cherbourg on the occasion of a recent launch. He ascended to 12,000 feet, and came down in the bay at twenty miles from Cherbourg. A number of steamers had been sent out to help if needed, and M. Duruof was taken on board one of them unhurt. The manœuvre was most cleverly executed with the help of an apparatus which M. Duruof had immersed in the sea to diminish the velocity of the balloon, and permit the boat to board the car.

A correspondent, writing from Waterloo, near Liverpool, asks if there are any works published on the Æolian Drift or Wind Drifting, its cause and cure.

The Institution of Civil Engineers has published its list of subjects for papers and prizes for session 1876-77. A copy may be obtained by applying at 25, Great George Street, Westminster, S.W.

The third number of the *Bothkamper Beobachtungen*, recently published, contains exclusively M. Lohse's researches in the years 1872 and 1873. The volume is in three parts:—1. Researches on the physical nature of the sun's surface. 2. Photographic registration of the sun-spots. 3. Meteorological observations in the year 1873. The promised fourth volume will contain M. Vogel's researches during the same period.

We have received the second part of the second volume of the "Proceedings of the Natural History Society of Glasgow," which contains numerous papers by Prof. John Young, Messrs. Harvie Brown, James Lumsden, Robert Gray, D. Robertson, J. Cameron, jun., and others. The most important of the communications are ornithological and entomological, some are peculiarly briefly noticed.

SOCIETIES AND ACADEMIES

London

Entomological Society, Aug. 2.—Sir Sidney Smith Saunders, vice-president, in the chair. Messrs. Harold Swale and J. S. Hillman were elected ordinary members.—Mr. Stevens exhibited *[illegible]* and *[illegible]* taken on an oak fence at Upper Norwood, and Mr. Champion exhibited *[illegible] 4-punctatus, Dendrophagus [illegible]*, and other rare Coleoptera from Aviemore, Inverness-shire. Mr. Forbes exhibited a specimen of *[illegible]* taken by him with sugar in the New Forest. From a despatch from H.M. Chargé d'Affaires at Madrid, a copy of which was forwarded to the secretary through the Foreign Office, it appeared that the damage done this year by the locusts was considerably less than that of last year, owing to the number of soldiers which the Government had been able to employ since the war was over, in assisting the inhabitants of the districts where the plague existed, in destroying the insects. Specimens of the locust, as well as a number of earthen tubes containing the eggs, were forwarded to the society, and on examination they were found to be the *Locusta [illegible]*, Fab. (*[illegible]*, Savigny).—Mr. McLachlan exhibited a series of thirteen examples of a dragon-fly (*Diplax meridionalis*, Selys), recently taken by him in the Alpes Dauphinés, remarkable for the extent to which they were infested by the red parasite described by De Geer as *Acarus libellulæ*. They were firmly fixed on the nervures at the base of the wing, almost invariably on the underside, and being arranged nearly symmetrically, had a very pretty appearance, the wings looking as if they were spotted with blood-red. He considered that the *Acari* must have attained their position by climbing up the legs of the dragon-fly when at rest.—Mr. F. Smith read a note on *Nematus gallicola*, Steph., the Gall-maker, so common on the leaves of species of *Salix*, but of which the male had, apparently, not previously been observed. From 500 or 600 galls collected by him in 1875, he had obtained a multitude of females, but only *two* males, and he thought that by perseverance in this way it would be possible to obtain the males of this and other allied species, of which the males were practically unknown, the female being capable of continuing the species without immediate male influence, and he argued from this that the long sought males of *Cynips* might some day be found by collecting the galls early in the year. He expressed his belief that Mr. Walsh had proved, beyond question, the breeding of a male *Cynips* in America, although the precise generic rank of the supposed *Cynips* was disputed by some of the members present.—The president (Prof. Westwood), who was unable to be at the meeting, forwarded some notes of the habits of a Lepidopterous insect, parasitic on *Fulgora candelaria*, by J. C. Bowring, with a description of the species and drawings of the insect in its different stages, by himself. It appeared that the Coccus-like larvæ were found attached to the dorsal surface of the *Fulgora*, feeding upon the waxy secretion of the latter, and covering itself with a cottony substance. From its general appearance the Professor was disposed to place the insect among the *Arctiidæ*. It was discovered many years ago by Mr. Bowring, and he (Mr. Westwood) had noticed it at the meeting of the British Association at Oxford, in 1860, under the name of *Epipyrops anomala*.—The Rev. R. L. Murray forwarded a paper by Mr. W. H. Miskin, of Brisbane, containing descriptions of new species of Australian Diurnal Lepidoptera in his own collection.

Mr. Edward Saunders communicated the third and concluding portion of his synopsis of British Hemiptera-Heteroptera.

Vienna

Imperial Academy of Sciences, June 16.—The following, among other papers, were read:—On an earthquake in Canea, Crete, on April 25, by M. Micksche. The waves of impulse came from the north. The sea was quiet, and there was no sound. The last earthquake was in January last year, and was more violent.—Communications from the laboratory of Prague University, by M. Linnemann. These relate to reactions with propylene.—On a gas battery of convenient form, by M. Mach. It consists of sixteen jars connected in pairs, by their like coatings. By a simple commutator the pairs can be connected together to an ordinary jar battery, or successively to a Franklin jar battery, and this combination can be quickly changed. Long and powerful sparks are had (16 ctm. *e.g.*).—Body-measurements of various peoples, made during the Austro-Hungarian expedition to Eastern Asia, by Dr. [illegible], and extended, by personal observations, by Dr. Weisbach. Dr. Weisbach distinguishes—I. Short heads, II. Medium heads, III. Long heads. Each of these divisions falls into *a*, prognathous, and *b*, orthognathous, and each of these subdivisions into 1, Long-armed, 2, Equal-limbed, 3, Short-armed. In this system the short-headed prognathous human races, whose arms are longer than the legs, stand lowest, *i.e.*, nearest to the apes, and the long-headed orthognathous and short-armed, stand highest.—A contribution to knowledge of Mediterranean fauna, by M. Hornes.—On a constant winding in the human brain, observed by M. Heschl.—On the development history of the [illegible], and the *[illegible]*, by M. Schenk.

June 22.—On an earthquake in Canea, Crete, on May 23, by M. Micksche. The disturbance may have come from Cyprus or Syria, or may be an awakening of the old volcanic action of Crete itself.—On the occurrence of the foraminiferal species, *Nubecularia*, in the Sarmatian sand of Kischenew, in Bessarabia, by MM. Karrer and Sinzow.

CONTENTS

THURSDAY, SEPTEMBER 14, 1876

GEORGE SMITH

THE untimely death of Mr. George Smith at the early age of thirty-seven, is a loss that can ill be repaired. Scholars can be reared and trained, but hardly more than once in a century can we expect a genius with the heaven-born gift of divining the meaning of a forgotten language and discovering the clue to an unknown alphabet. The marvellous instinct by which Mr. Smith ascertained the substantial sense of a passage in the Assyrian inscriptions without being always able to give a philological analysis of the words it contained, gave him a good right to the title of "the intellectual picklock," by which he was sometimes called. The pioneer of Assyrian research, and the decipherer of the Cypriote inscriptions, he could be all the less spared at the present moment, when a key is needed to the reading of those Hamathite hieroglyphics to which the last discoveries he was destined to make have given such an unexpected importance.

Mr. Smith was born of poor parents, and his school-education was consequently broken off at the age of fifteen, when he was apprenticed to Messrs. Bradbury and Evans to learn the art of engraving. While in this employment he often stole half the time allowed for dinner for visits to the British Museum, and saved his earnings to buy the works of the leading writers on Assyrian subjects. Sir Henry Rawlinson was struck with the young man's intelligence and enthusiasm, and after furnishing him with various casts and squeezes, through which Mr. Smith was led to make his first discovery (the date of the payment of tribute by Jehu to Shalmaneser (he proposed to the trustees of the Museum that Mr. Smith should be associated with himself in the preparation of the third volume of the "Cuneiform Inscriptions of Western Asia." This was in 1867, and from this year Mr. Smith entered upon his official life at the Museum and definitely devoted himself to the study of the Assyrian monuments. The first fruits of his labours were the discovery of two inscriptions, one fixing the date of a total eclipse of the sun in the month Sivan or May, B.C. 763, and the other the date of an invasion of Babylonia by the Elamites in B.C. 2280, and a series of articles in the *Zeitschrift fur Ægyptische Sprache*, which threw a flood of light upon later Assyrian history and the political relations between Assyria and Egypt.

In 1871 he published the "Annals of Assur-bani-pal," or Sardanapalus, transliterated and translated, a work which involved immense labour in the preparation of the text and the examination of variant readings. This was followed by an excellent little pamphlet on the chronology of Sennacherib's reign and a list of the characters of the Assyrian Syllabary. About the same time he contributed to the newly-founded Society of Biblical Archæology a very valuable paper on "The Early History of Babylonia" (since republished in the "Records of the Past"), as well as an account of his decipherment of the Cypriote inscriptions which had hitherto been such a stumbling-block and puzzle to scholars. The Cypriote Syllabary as determined by him has been the basis of the later labours of Birch, Brandis, Siegismund, Deecke, Schmidt, and Hall.

It was in 1872, however, that Mr. Smith made the discovery which has caused his name to be a household word in England. His translation of the "Chaldean Account of the Deluge" was read before the Society of Biblical Archæology on the 3rd of December, and in the following January he was sent to excavate on the site of Nineveh by the proprietors of the *Daily Telegraph*. After unearthing the missing fragment of the Deluge story, he returned to England with a large and important collection of objects and inscriptions. Among these were fragments which recorded the succession and duration of the Babylonian dynasties, a paper on which was contributed by the discoverer to the Society of Biblical Archæology. It was in connection with these chronological researches that Mr. Smith's invaluable volume on the "Assyrian Eponym Canon" was written for Messrs. Bagster in 1875. Shortly afterwards he again left England to continue his excavations at Kouyunjik for the Trustees of the British Museum, and in spite of the difficulties and annoyances thrown in his way by the Turks, he succeeded in bringing home a large number of fragmentary tablets, many of them belonging to the great Solar Epic in twelve books, of which the episode of the Deluge forms the eleventh lay. An account of his travels and researches was given in his "Assyrian Discoveries," published at the beginning of 1875. The remainder of the year was occupied in piecing together and translating a number of fragments of the highest importance, relating to the Creation, the Fall, the Tower of Babel, &c. The results of these labours were embodied in his book, "The Chaldean Account of Genesis."

The great value of these discoveries induced the Trustees of the Museum to despatch Mr. Smith on another expedition in order to excavate the remainder of Assur-bani-pal's library at Kouyunjik, and so complete the collection of tablets in the British Museum. Mr. Smith accordingly went to Constantinople last October, and after some trouble succeeded in obtaining a firman for excavating. He set out for his last and fatal journey to the East in March, taking with him Dr. Eneberg, a Finnic Assyriologue. While detained at Aleppo on account of the plague, he explored the banks of the Euphrates from the Balis northward, and at Yerabolus discovered the ancient Hittite capital, Carchemish—a discovery which bids fair to rival in importance that of Nineveh itself. After visiting Devi, or Thapsakus, and other places, he made his way to Bagdad, where he procured between two and three thousand tablets discovered by some Arabs in an ancient Babylonian library near Hillah. From Bagdad he went to Kouyunjik, and found, to his intense disappointment, that owing to the troubled state of the country it was impossible to excavate. Meanwhile Dr. Eneberg had died, and Mr. Smith, worn out by fatigue and anxiety, broke down at Ikisji, a small village about sixty miles north-east of Aleppo. Here he was found by Mr. Parsons, and Mrs. Skene, the consul's wife at Aleppo, and a medical man having been sent for, conveyed him by easy stages to Aleppo, where he died August 19th. He has left behind him the MS. of a "History of Babylonia," intended to be a companion volume to his "History of Assyria," published by the S.P.C.K. last year.

Mr. Smith's obliging kindness was only equalled by his modesty. Shortly after his return from his first expedition

he was showing the present writer some of the tablets he had found, when a lady and gentleman came up and asked various questions, to which he replied with his usual courtesy. They thanked him and were turning away when, hearing his name pronounced, the lady asked: "Are you Mr. Smith?" On his replying "That is my name, madam," she exclaimed, "What, not the *great* Mr. Smith!" and then, like the gentleman with her, insisted upon having "the honour" of shaking hands with the distinguished Assyriologue, while the latter crimsoned to the roots of his hair. His loss is an irreparable one to Assyriology, even beyond his powers as a decipherer, as his memory enabled him to remember the place and nature of each of the myriad clay fragments now in the Museum, while his keenness of vision made his copies of the minute characters of the tablets exceptionally trustworthy. It is distressing to think that he leaves behind him a wife and large family of small children, the youngest of whom was born but a short time before his last departure from England. A. H. SAYCE

THE NORWEGIAN TOURISTS' ASSOCIATION

Year-book of the Norwegian Tourists' Association for 1875 (*Den Norske Turistforenings Årbog for* 1875.) (Kristiania: Cammermeyer).

THIS year-book, which is the eighth of a series issued by the Association, contains some information likely to be useful to those who intend to visit the *fjelds* of Norway, and two papers at least of scientific interest by Mr. A. Helland. The indefatigable mountain-climbers, Mr. E. Mohn and Mr. Wm Cecil Slingsby, have each contributed a paper on their adventures during short excursions made on the Jotunheim-fjeld ("Adventures on the Fjelds," and "An English Lady in Jotunheimer"). These accounts, written in a lively, pleasant style (the last in English), will be read with interest by tourists who are in search of new fields of exploration. In the paper of O. A. C. "Bagatelles from a Journey in the Nordland," the reader will find some fine description of nature and life in the northern parts of the Scandinavian peninsula.

The paper by Mr. A. Helland, "On 'Cirques' and Sack-valleys,'[1] and on their importance in the theories of the Formation of Valleys," will certainly be perused with profit by the geologist.[2] After a description of cirques and sack-valleys, and of the forms intermediate between the two, Mr. Helland remarks that the openings of the cirques are generally directed towards the north. This law, he says, is well illustrated by a large scale map of the Jotunfjelds, constructed by Capt. Hertzberg; and from a table, in which the author gives the directions of thirty-seven cirques of different magnitudes (from 0·3 to 4 kilometres long), it is seen that twenty-five cirques are directed towards points lying between north-west and north-east, cleven between north-west and south-west or north-east and south-east, and one points towards the south-east. Certainly in other localities there are cirques pointing even due south, but these are only exceptions to the general rule. Besides, when a valley has a west-east direction, or when the slope of a fjeld follows this direction, it is on the slope which faces to the north that semi-circular indentations or little cirques are found.

A second law which may be established for the cirques of the parts of Norway explored by the author, is, that the largest are generally found in the neighbourhood of the highest peaks of the country.

As to the origin of the cirques, Mr. Helland refers to a note of Mr. Lorange, which he gives *in extenso*, and in which the author, though not a geologist by profession, makes some very valuable observations on the cirques, on their close relations with glaciers, existing and extinct, and with old moraines. His notes on the transport of blocks from the interior of the cirques, and on the directions of their transit, show how important was the part played by ice in the excavation or in the clearing of cirques. The conclusions arrived at by Mr. Lorange, and supported by Mr. Helland are, that cirques, as well as sack-valleys, were necessarily excavated with the aid of glacier-ice. But the ice did not act as a direct excavating agent; it only cleared away the *débris* which had accumulated in the cirques, the rock being disintegrated by the incessant intermittence of the freezing and thawing of water in the fissures. Doing little to excavate the valley, the glacier acts as a powerful means of transport of the disintegrated parts of the rock, where such a means is wanting, as on the tops of mountains, there the *débris* accumulates and protects the underlying rock from further disintegration. The tarns, so numerous at the bottoms of cirques and of sack-valleys, were formed, the author supposes, by the same process, the rocks being disintegrated when the water freezes under the glacier during winter. This theory of the transport power of glaciers is supported by some authorities in England, but we think that it meets with two great difficulties. It is in contradiction with the well-known fact, that in the valleys of the Alps the ice has acted as a sheet, protecting the rock from disintegration; that the disintegration proceeds far more rapidly above the glacier than beneath it. And secondly, the theory does not explain why the disintegration should go on so rapidly in the head of the valley and so slowly in its lower parts (the differences of height and climate being trifling), as to produce a very great semi-circular enlargement at the head of the valley. We believe, therefore, that so long as it is not admitted that a glacier, charged on its lower surface with a mass of *débris*, is really a mighty excavating agent, we cannot come to a satisfactory explanation of the cirques. The observation of Mr. Helland that the openings of the cirques are generally directed to the north, *i.e.* to the part of horizon *from* which came the ice in many instances, suggests a question which we will simply refer to without entering into details. Were not some cirques, *or a part of the enlargements of some cirques*, excavated by the ice during its *ascending* motion from the valley on the fjeld? Those who accept the molecular motion of glacier-ice, *i.e.* its perfect plasticity or viscosity, with all the consequences of this theory, certainly will not find the question extravagant; they will remember that the motion of ice *up* the valleys, and even a motion on slopes from 20° to 63° is an established fact.

[1] "Om botner og sækkedale, samt deres betydning for theorier om dalenes dannelse." A "botn," a semi-circular indentation in the mass of the field, is what is called in the Alps a "cirque." A "sækkedal," *i.e.*, a valley, the head of which presents a semi-circular enlargement, or a "cirque," a valley which ends in a *cul-de-sac*, might be called a "sack-valley," a literal translation of the word "sækkedal."

[2] This paper is reprinted from the valuable periodical, *Geologiska Föreningens i Stockholm Förhandlingar*.

In the valleys which have, for example, a west-to-east direction, and which were crossed by the ice moving from north to south, the plastic ice *ascended* the slopes which faced towards the north; and also did it ascend on the fjelds when it moved *up* a valley, a phenomenon which, we know, is not at all uncommon.

A second short paper, by Mr. Helland, gives a table of the dimensions, heights above sea-level, and depths of twenty Norwegian lakes, from which it is seen that these lakes are, as in the case of the Italian lakes, deeply excavated below the sea-level; thus, for example, the bottoms of the Horningsdalvand and of the Mjösen lie respectively 432 and 331 metres below the level of the sea.

Without speaking of other short papers, we will note that the "Year-Book" contains some practical information on guides, on the regulations relative to hunting and fishing, and finally, the Annual Report of the Committee of the Society. It will be seen from this Report that the Association is rapidly developing; during 1875 the number of Fellows increased by 230, and reached, at the end of the year, the number of 1,247, of whom 166 are foreign Fellows, 63 belonging to England. A. L.

OUR BOOK SHELF

British Manufacturing Industries. Edited by G. Phillips Bevan, F.G.S. Shipbuilding, by Capt. Bedford Pim, R.N., M.P.; Telegraphy, by Robert Sabine, C.E.; Agricultural Machinery, by Prof. Wrightson; Railways and Tramways, by D. Kinnear Clark, M.Inst.C.E. (London: Stanford, 1876.)

THIS ought to be one of the most popular volumes of this instructive series, the contents are so varied, the subjects so generally interesting, and the amount of information conveyed so large. The various writers, moreover, have managed to treat their subjects in a manner that will be understood and enjoyed by even the most general readers. Capt. Pim is evidently quite at home in his subject, which he writes about in the spirit both of a sailor and a Member of Parliament. Of course only the merest sketch of so large a subject can be given in the space at his disposal, but in that space he contrives to convey a substantial amount of information, commencing with the log which conjecture makes the first form of boat, down to the latest armour-plated ship-of-war. He writes in rather a desponding tone of the present condition of British shipping, both in the merchant service and in the navy, and thinks our country behind others in modes of construction. Our navy is evidently far from perfect, and those who have its control, if they have also the welfare of our country at heart, would do well to weigh Capt. Pim's criticism. One of the surest remedies is undoubtedly the rigid application of scientifically-conducted experiment to shipbuilding. Mr. Sabine gives a very complete sketch of telegraphy as an industry, of the various forms of telegraph, their construction, the instruments in use, and the materials employed. He, too, indulges in some wholesome criticism, which those who provide the means for constructing telegraphs would do well to peruse. Prof. Wrightson (of Cirencester Agricultural College) gives a very instructive account of the multifarious machinery now used in the various operations by which agriculture is carried on, from clearing and ploughing the land to preparing crops and stock for market and consumption. Mr. Clark gives much valuable information on the construction and working of railways, showing the progress made since they were first started, describing some of the latest improvements and most important enterprises, and entering into details as to cost, revenue, and other points, which all who are interested in railways will find useful. His short notice of Tramways is also interesting; their cost of construction will surprise many, if not the large earnings which they make. Altogether, the volume is one of varied and genuine interest.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Miniature Physical Geology

UNDER this title there is a brief but very interesting article in NATURE, vol. xiii. p. 310, describing, among other things, some miniature earth-pillars at Bournemouth. These are due to the slight protection afforded by a hard seam in the sandy rock to a more friable layer beneath, when the whole is undergoing denudation by rain. It is a thing which I have seen more than once; but in the district of Luchon (Pyrenees) during the present summer, I have come across instances of earth pillars in miniature, yet more perfect than the above. The most striking case was on a slope in the wood on the right bank of the Cascade d'Enfer (Val de Lis). This slope consisted of a rather tenacious clay, filled with small angular fragments of granitoid rock. A slip, or the action of rain, had formed a little corrie half a yard or so wide, and on both sides of it the slope was studded with earth pillars, more or less perfect, each capped by its little stone. These caps were rather tabular in shape, generally from a quarter of an inch to an inch broad. Several of the pillars were so exactly models of those at Botzen, that, if drawn on the same scale, they could not be distinguished. The sides of the large pillars are furrowed and fluted by little rills of rain; so were these. Boulders smaller than the great capstone are imbedded in the matrix of the pillars, and, themselves exercising a protective influence are supported on brackets or pilasters of earth; so was it here; yet all this on the tiniest scale, for the largest and best-formed pillar had a general height of only about $1\frac{1}{4}$ inches, rising on one side about as much again above the bed of a miniature ravine. I also saw a large number of similar but more stumpy pillars by the side of the path from the Port de la Picade to the Hospice de France. T. G. BONNEY

St. John's College, Cambridge

Visual Phenomena

THE letter of Mr. Arnulph Mallock (NATURE, vol. xiv. p. 350) has very much interested me, having recently found that my vision is an exception to that of other persons whom I have tested in the matter.

For instance, I see the light of *distant* street lamps clearly defined without any diverging rays proceeding from the points of light.

Possibly this peculiarity of vision may partly account for my having glimpsed the two outer satellites of Uranus with a refractor of only 4·3 inches in aperture, during the last opposition of the planet, and which caused some discussion when my observations were read before the Royal Astronomical Society.

I have also been successful in detecting very faint stars close to brighter ones with comparatively small telescopic aid.

I may remark that I am long-sighted, as I can read the columns of NATURE readily between the distances of twelve to thirty inches, though my more convenient reading distance is about sixteen inches.

It would be interesting to ascertain whether there are many such exceptions to the "visual phenomena" pointed out by Mr. Mallock. I. W. WARD

Belfast, Sept. 5

ALTHOUGH there can be little doubt that the explanation of the long streaks of light seen on examining a bright point through a half-closed eye, which is given in NATURE, vol. xiv. p. 350, is the right one, and may be proved to be so in other ways than those noted, yet I think the Fig. 5, which is supposed to represent the course of the rays of light, ought not to

remain uncorrected. It will be seen in that figure that the eye, and particularly the front convex surface of the crystalline lens, makes the rays diverge, instead, of course, of making those that catch the watery prism converge a little less.

J. F. BLAKE

Antedated Books

I AM sorry to have to trouble you again under this heading, but Mr. Sharpe's second letter necessitates a short reply. I did not accuse Mr. Sharpe, in my original letter, of having *wilfully* misdated his book, I never even mentioned his name. I merely stated the facts and added a few comments to show that the date *was* a matter of some importance. Mr. Sharpe is now angry because I do not withdraw a charge which I never made. If he had simply explained in his first letter that the misdate was an error of his publisher and promised that it would not occur again, the matter would have been ended. When he proceeded to attack me for doing what I believed to be my duty, he naturally provoked an unpleasant answer.

F. Z. S.

OUR ASTRONOMICAL COLUMN

VARIABLE STARS (1), Mira Ceti.- Herr Julius Schmidt, Director of the Observatory at Athens, by a mean of three sets of comparisons with δ and γ Ceti and α Piscium, fixes the first maximum of 1876 to February 3·7, the date inferred from Argelander's formula of sines being January 17·0. The minimum by the same formula occurred on September 1.

(2) R Hydræ. Of this object, so difficult to observe satisfactorily in these latitudes, Herr Schmidt observed a maximum 1876, April 12·5.

(3) The same observer refers to a secondary minimum of the well-known variable star R Leonis, discovered by Koch in 1782. For the present year his observations have given the principal maximum May 7·7, the secondary minimum May 21·7, a maximum June 1·7.

(4) 16 Eridani. There appear to be grounds for adding this star to the list of variables. It was considered as high as 3·4 by Piazzi, 4·3 by Heis, 4 by Flamsteed, and in the Washington general catalogue it is 4·4. Brisbane calls it 6, Argelander, once 5, and once 6. Smyth says, "it appeared more than once diminished to nearly a fifth magnitude."—This star is also τ^4 Eridani of B.A.C., but as Bayer's map has no fewer than nine stars to which this letter is applied, it appears preferable to adopt Flamsteed's number.

(5) We learn from Dr. Gould, that the variable star in Musca, to which he has already directed attention, has certainly a period shorter than that of any other known variable star—or about thirty hours only. Its variation is such that at minimum it is fairly beyond unassisted vision in the sky of Cordoba, though distinctly seen at maximum.

(6) In a short list of variable stars stated by Dr. C. H. F. Peters, of Hamilton College, Clinton, U.S., to have been recently detected, which appears in *Comptes Rendus*, 1876, August 28, and in M. Leverrier's *Bulletin International*, of Sept. 6, is one in R.A. (1860), 15h. 13m. 21s., N.P.D. 109° 53′, said to vary between the sixth and eleventh magnitudes. This star, however, is not new; it is No. 76 of Schönfeld's last catalogue, and was discovered by M. Borelley in 1872. Schonfeld's limits are 8·0 and 12·5, the latter doubtful, and he assigns, as a rough approximation to elements:

$$\text{Maximum} \ . \ . \ . \ 1874, \text{June } 17 + 193^{d} \text{ E.}$$

The first star on the same list is No. 6 of Schönfeld's list in the introduction to his second catalogue (S. Libræ).

AN INTRA-MERCURIAL PLANET (?).—The account of the observation of a round spot on the sun's disc, remarked on April 4, but not seen either on the preceding or following morning, which was quoted last week, from *L'Institut* of August 30, appears not to have been there given accurately. By the *Comptes Rendus* of August 28, we learn that M. Leverrier made the statement on the authority of a letter from Prof. Rudolph Wolf, Director of the Observatory at Zurich, dated August 26. Prof. Wolf says:—"It will doubtless interest you to learn that M. Weber, at Peckeloh, saw on the 4th of April last, at 4h. 25m. M.T. at Berlin, a round spot upon the sun, which was seen without spot on the same morning and on the following one, not only by M. Weber, but also by me and by M. Schmidt at Athens. (For the observation of M. Weber, see No. 34 of the *Wochenschrift für Astronomie*.) I remark that the date of M. Weber's observation follows that of M. Lescarbault by

$$6219 \text{ days} = 148 \times 42^{d}\cdot02,$$

which is curious enough on comparison with what I have published on the subject at the time. See my 'Handbuch der Mathematik und Astronomie,' vol. ii., p. 327."

So that instead of the spot having been noticed in three different and distant places, it was remarked at Peckeloh, near Munster only, though the observations by Prof. Wolf, at Zurich, and Herr Julius Schmidt, at Athens, establish the fact of the sun having been without the spot in question shortly before and after its observation by Herr Weber, who is well known by his observations on the zodiacal light and other phenomena.

At present the particulars of the observation are not to hand, but it is singular that Prof. Wolf's period of 42·02 days not only accords with the observation of M. Lescarbault, so far as regards an inferior conjunction of the body with the sun on March 26, 1859, but it also agrees with that of Mr. Lummis, March 20, 1862, and with the one recorded by Decuppis at the Collegio Romano, on October 2, 1839, at the opposite node, at least within probable transit-limits. Particulars of Mr. Lummis's observation will be found in vol. xxii. of the *Monthly Notices* of the Royal Astronomical Society; that of Decuppis was thus mentioned at the sitting of the Paris Academy of Sciences, 1839, December 16:—"M. Decuppis announces that on October 2, continuing the observations which he had been making upon the spots of the sun, he saw a black spot, perfectly round, and with border sharply defined, which advanced upon the disc, with a rapid proper motion, such that it would have traversed the diameter in about six hours. M. Decuppis thinks that the appearances which he has observed can only be explained by admitting the existence of a new planet."

If we were to accept the particulars of the various observations of a similar character as they are recorded, it would be impossible to refer them to a single body, no matter what the excentricity of the orbit might be assumed to be, but most unfortunately these observations have on no one occasion so far been taken by a practised astronomer with proper micrometrical assistance. On the contrary, they have mostly fallen to the lot of occasional observers, who have contented themselves with eye-estimations of position on the sun's disc, from which little can be definitely ascertained.

The Peckeloh observation of April 4 naturally suggests frequent observation of the sun's disc from the middle of the present month to the middle of October, particularly about October 10.

[Since the above was in type, we learn from a Paris correspondent that M. Leverrier has made a further communication to the Academy on the subject of an intra-Mercurial planet or planets. Instead of a period of forty-two days, as suggested by Prof. Wolf, he thinks one of twenty-eight days more probable; and this, it may be observed, is an aliquot part of Prof. Wolf's period. But notwithstanding a period of twenty-eight days accords with a number of the observations referring to round black spots upon the solar disk, M. Leverrier is stated to

have expressed an opinion in favour of the existence of two planets at nearly the same mean distance. With respect to a period of twenty-eight days, we remark that reckoning from 1876, April 4, it will agree with the observations of Lescarbault and Lummis, but not with that of Decuppis; while it also agrees with the observation of Stark, 1819, October 9, a very definite one, which is not brought in with a period of forty-two days. The shorter period will be found to correspond with a mean distance of 0·18.]

SCIENCE IN SCHOOLS

THE accompanying letter, signed by several men of Science and Head-masters, has been sent to the General Committee of the British Association:—

DEAR SIR,—It is hoped that a Committee may be formed at this year's meeting of the British Association for the promotion of Science Teaching in Schools. Its proposed functions would be:—

1. To communicate with head-masters and governing bodies as to carrying out the recommendations contained in Report VI. of the Science Commission, and to offer advice, if required, on all necessary details of selection, arrangement, and outlay.

2. To press upon the Universities such steps in connection with the pending Bill in Parliament as may beneficially influence school teaching of science.

3. To watch the action of Government in any proposal made by them either in pursuance of Lord Salisbury's Bill or in giving effect to the Duke of Devonshire's Commission, and to hold a brief for science-teaching at schools in reference to all such legislation.

We desire to bespeak your attention to and interest in this proposal, which appears to us in all respects a timely one.

THE BRITISH ASSOCIATION

GLASGOW, *Tuesday*

THE Association finds a fitting home in Glasgow, which has few rivals either in earlier or later scientific reputation. The force of long-continued scientific traditions, added to the present encouragement given to science, and I must also say, to the nearness of the finest holiday localities, makes this one of the most brilliant of recent meetings. Not only is the total number of members and associates attending very high, over 2,700, but the true chiefs of science are present in great strength. It cannot be said that the Association itself is this year at all below its high aims. The majority of papers are really scientific, and do not emasculate the truth in the effort to popularise it. Discussions have been very interesting, judging from the perseverance with which they have been listened to. The reception given by the people of Glasgow is worthy of the city, although it is possible that in the details and refinements of arrangement, Bristol excelled. This was especially manifested in regard to some of the excursions. But it is evident that the very best efforts of the north have been put forth in every way, and the general result is undeniably successful. The charming situation of the University Buildings, in which all the sections but one hold their meetings, is a very great advantage.

From the Report of the Council it will be seen that grants in aid of scientific objects have been made during the year to the amount of 1,092*l*. The income of the year has reached 3,743*l*., and the cash balance, 764*l*., exceeded that of last year by 624*l*.

The President's Address did not excite general enthusiasm among the audience, partly because the great size of the building and the comparative weakness of the speaker's voice prevented many from hearing well, partly, also, because it was such as to impress most those who think most. The address manifested the combination in its author of qualities seldom marching together; deep regard for elder times and their achievements, wide knowledge of the position of science at the present day, perception of the true relationships, the real connexus of pure and applied science, a realisation, founded on careful study of the way in which the scientific cultus affects human nature, and the rise and fall of nations. It would be vain to seek for scientific arrogance and conceit in Dr. Andrews's deliverance, and if one may forecast, it may be expected to have as much influence on future thought and public action as almost any recent utterance from the presidential chair of the British Association, without any tendency to provoke the hostility of the unscientific.

Among the presidential addresses, that of Mr. Wallace to the Biological Section seems to have attracted much notice; and there is no doubt of its great value, for, scarcely occupying any ground covered by his recent great work on "The Geographical Distribution of Animals," he may be said to have laid the foundations of a new science out of "waste materials" already existing. Thus another group of scattered fragments is beginning to be sought by right processes, in order that a coherent edifice may be erected. Sir William Thomson returned again to the charge against the exorbitant demands of geologists for "time." If he is right, of course some geological theories must be altered; but perhaps Sir William will not have to wait long for an answer. It was singular that Prof. Young, in the Geological Section, should have chosen a subject agreeing so largely with Sir William Thomson's. His views, carried out into more geological detail, imply that we are to look for a general reconstruction of much that is held to be settled in geological theory. He calls loudly for precision in geological phraseology, believing that there is nothing more urgently needed to secure progress in the science than some of that accuracy of conception and expression which distinguishes mathematical and physical science. Capt. Evans's address on Geography will perhaps disappoint some who think the questions of oceanic circulation are practically settled, but an open confession of difficulties and ignorance is better than any false security. Such confessions have been very general among the best men at this meeting—a favourable augury of coming victories for science.

On the whole the sections have done hard work, and comparatively little sacrifice of scientific rigour and form has been made for the sake of making subjects popular. The Duke of Argyll's address on the Geology of the Highlands was a *bonne bouche* for the untechnical, and was much run after. The Duke has shared "lionship" with Commander Cameron and Sir C. Wyville Thomson; consequently the heart of Africa and the depths of the sea are among the favourite subjects here. Sir William Thomson has, of course, been at home on the great Tide question, denouncing the British Hydrographic Department for its supineness, by which very laborious and expensive efforts are left to private individuals. One of the most lively encounters has concerned the junction of the granites and Old Red Sandstone in Arran. It was suggested that Mr. Wunsch and Dr. Bryce should adjourn to the locality to fight it out, but without hammers. The chemists had a field-day on the disposal of the sewage of towns. Irrigationists and precipitationists continued their controversies, giving excuse to great towns still to postpone dealing with the subject. While the doctors, or rather chemists, differ, the sewage is emptied into the river.

Prof. Tait's discourse on Force was very characteristic. One important advantage gained by the audience would probably be an impression of the necessity of accuracy in the use of words.

Sir C. Wyville Thomson's address on the Results of

the *Challenger* Expedition was very successful, and highly appreciated. A good voice was added to a most agreeable and flowing delivery, and as little as possible of complicated ideas or reasoning was introduced.

Two *conversaziones* took place on Thursday evening, for what reason is not apparent. One was under the superintendence of the local committee, in the Royal Exchange. There was a little pretence at science, but the assembly was converted into a ball. Is it right that money raised by the local committee in the name of the British Association should be devoted to such a purpose? If a ball is wanted, let there be a separate subscription for that avowed purpose. The other assembly, under the auspices of the Philosophical Society (of which Sir William Thomson is president), took place in the Corporation Galleries and the rooms of the Society. Art and science were here fitly combined. Physical apparatus received considerable illustration. Sir William Thomson's demonstration on smoke rings and his new patent syphon recorder being especially interesting. Mr. James Thomson, F.G.S., attracted attention by his exhibition of a series of sections of fossil corals, beautifully shown by Birrell's new oxyhydrogen apparatus. The great special collection of carboniferous fossils in these galleries was exceedingly creditable to the geologists of the Glasgow district; Mr. James Thomson's very large collections, including his splendid Labyrinthodont remains (Pteroplax, &c.), formed a considerable proportion of the whole.

The museums of Glasgow are numerous and scattered. To a considerable extent the same things are displayed over again in the Hunterian Museum at the University, the Kelvingrove Museum in the park of that name, the Andersonian at Anderson's University, the Museum of the Society of Naturalists in the Queen's Rooms, and the Museum in the Corporation Galleries. Very great labour has been expended in the formation of special collections at these places, but we can only notice a very few of these. In the University Museum the display of Mr. John Young's private collection of fossils was most interesting by reason of the great number and beauty of the preparations of minute forms, especially of Foraminifera, Sponges, Echinoderms and Polyzoa. Unfortunately the great roof of the Museum has no light in it whatever, an inconceivable detraction from its value. Other most noticeable collections were a splendid series of Labyrinthodonts and Fishes from Carluke Collieries, the exhibitor of which desired his name to be unknown, and Mr. David Robertson's collection of recent and Pleistocene invertebrates. The great special exhibition of mechanical inventions and industrial processes at the Kelvingrove Museum must, we regret to say, be dismissed with a single word of high commendation. Rare plants and animals were to be seen at the Queen's Rooms, including many unique specimens from Scottish habitats. Utricularia and Drosera are of course brought forward.

The assembly of foreigners on this occasion is very notable. Section A includes in its forces Prof. Cremona, of Rome; M. Janssen, of Leyden; Prof. Wullner, of Aix-la-Chapelle; Prof. Eccher, of Florence; Prof. Fischer, Prof. von Quintus Icilius, of Hanover; Profs. Stoletow and Wladirmiosky. Section B has the aid of Dr. Biedermann, of Berlin. Section C, Dr. A. Fritsch, of Prague; Prof. von Lasaulx, of Breslau; Prof. F. Roemer, of Breslau; Section D rejoices in the presence of Ferdinand Cohn and Grube, of Breslau; Ernst Haeckel, of Jena; Kronecker, of Leipsic; and Prof. Morren, of Liége; the Chevali r Negri reinforces Section E; and M. Bergeron, of Paris, Section G.

The excursion programme, as might be expected in this neighbourhood, has been only too embarrassing. Saturday was very generally devoted to pleasure, although the mathematicians and physicists cleared off a long list of papers, and two other sections sat during part of the day. Those who could not devote the whole day to excursions had abundant entertainment provided for them in Glasgow. Cameron's lecture to working men was naturally very successful, and Dr. Carpenter subsequently spoke at length on the humane treatment which should be accorded to savages. One of the most interesting trips was made by Mr. Duncan and a small party of zoologists to Loch Fyne and the coast of Bute for the purpose of dredging. Many successful hauls were made, bringing up abundance of Comatulas, Aphrodites, Ascidians, and Echini. Another dredging party went with Mr. A. B. Stewart to Wemyss Bay. An attempt at dredging in Loch Lomond only gave "a beggarly account of empty bags." A geological party went to Ballagan, Finnich Glen, &c., under the guidance of Mr. Wilson, of Aucheveck. No very special scientific interest appears to be included in the excursions for Thursday next, when Paisley Abbey, Arran, Rothesay, and Loch Long, are to be visited.

So we are to meet in Dublin in 1878. Leeds pleaded hard, claiming that there was a sort of understanding in their favour last year. But the idea of alternating the meetings between a university town and a great manufacturing town prevailed, in addition, no doubt, to the eminence of the Dublin academicians attending the meeting. Scarcely less interesting was the choice of a president for the Plymouth meeting. The nomination of Prof. Allen Thomson by Dr. Hooker was at once an honour to Glasgow and a demonstration of regard for those studies of anatomy and embryology which do not always secure public renown. The personal qualities of Dr. Allen Thomson make him all that could be desired for a president. Of course his nomination was unanimously accepted. The vice-presidents appointed were the Earl of Mount-Edgcumbe, the Earl of Devon, Lord Blachford, Mr. W. Spottiswoode, F.R.S., Mr. W. Froude, F.R.S., and Mr. C. Spence Bate, F.R.S.; local secretaries, Prof. W. G. Adams, Mr. W. Square, and Mr. Hamilton Whiteford. Mr. P. L. Sclater, F.R.S., was elected one of the general secretaries, in the place of Dr. Michael Foster, F.R.S., who has resigned. We meet again in Plymouth on August 15, 1877.

SECTION A.

MATHEMATICAL AND PHYSICAL

OPENING ADDRESS BY PROF. SIR WILLIAM THOMSON, F.R.S., D.C.L., &c., PRESIDENT.

A CONVERSATION which I had with Prof. Newcomb one evening last June, in Prof. Henry's drawing-room, in the Smithsonian Institution, Washington, has forced me to give all my spare thoughts ever since to Hopkins's problem of Precession and Nutation, assuming the earth a rigid spheroidal shell filled with liquid. Six weeks ago, when I landed in England after a most interesting trip to America and back, and became painfully conscious that I must have the honour to address you here today, I wished to write an address of which science in America should be the subject. I came home, indeed, vividly impressed with much that I had seen both in the Great Exhibition of Philadelphia and out of it, showing the truest scientific spirit and devotion, the originality, the inventiveness, the patient persevering thoroughness of work, the appreciativeness, and the generous openmindedness and sympathy, from which the great things of science come.

Θέλω λέγειν Ἀτρείδας
Θέλω δὲ Καδμὸν ᾄδειν.

I wish I could speak to you of the veteran Henry, generous rival of Faraday in electromagnetic discovery; of Peirce the founder of high mathematics in America; of Bache, and of the splendid heritage he has left to America and to the world in the United States Coast Survey; of the great school of astronomers which followed, Gould, Newton, Newcomb, Watson, Young, Alvan Clarke, Rutherford, Draper, father and son: of Commander Belknap and his great exploration of the Pacific depths by pianoforte wire, with imperfect apparatus supplied from Glasgow, out of which he forced a success in his own way;

of Captain Sigsbee, who followed with like fervour and resolution, and made further improvements in the apparatus by which he has done marvels of easy, quick, and sure deep-sea sounding in his little surveying ship *Blake;* and of the admirable official spirit which makes such men and such doings possible in the United States Naval Service. I would like to tell you too of my reason for confidently expecting that American hydrography will soon supply the data from tidal observations, long ago asked of our Government in vain by a Committee of the British Association, by which the amount of the earth's elastic yielding to the distorting influence of the sun and moon will be measured; and of my strong hope that the Compass Department of the American Navy will repay the debt to France, England, and Germany so appreciatively acknowledged in their reprint of the works of Poisson, Airy, Archibald Smith, Evans, and the Liverpool Compass Committee, by giving in return a fresh marine survey of terrestrial magnetism, to supply the navigator with data for correcting his compass without sights of sun or stars.

Can I go on to precession and nutation without a word of what I saw in the Great Exhibition of Philadelphia? In the U.S. Government part of it, Prof. Hilgard showed me the measuring-rods of the U.S. Coast Survey, with their beautiful mechanical appliances for end measurement, by which the three great base lines of Maine, Long Island, and Georgia, were measured with about the same accuracy as the most accurate scientific measurers, whether of Europe or America, have attained in comparing two metre or yard measures.

In the United States telegraphic department I saw and heard Elisha Gray's splendidly worked-out electric telephone actually sounding four messages simultaneously on the Morse code, and clearly capable of doing yet four times as many with very moderate improvements of detail; and I saw Edison's automatic telegraph delivering 1,015 words in 57 seconds; this done by the long-neglected electro-chemical method of Bain, long ago condemned in England to the helot work of recording from a relay, and then turned adrift as needlessly delicate for that. In the Canadian department I heard "To be or not to be, ... there's the rub," through an electric telegraph wire; but, scorning monosyllables, the electric articulation rose to higher flights, and gave me passages taken at random from the New York newspapers:—"S.S. Cox has arrived" (I failed to make out the S.S. Cox); "The City of New York," "Senator Morton," "The Senate has resolved to print a thousand extra copies;" "The Americans in London have resolved to celebrate the coming 4th of July." All this my own ears heard, spoken to me with unmistakable distinctness by the thin circular disc armature of just such another little electro-magnet as this which I hold in my hand. The words were shouted with a clear and loud voice by my colleague-judge, Prof. Watson, at the far end of the telegraph wire, holding his mouth close to a stretched membrane, such as you see before you here, carrying a little piece of soft iron, which was thus made to perform in the neighbourhood of an electro-magnet in circuit with the line motions proportional to the sonorific motions of the air. This, the greatest by far of all the marvels of the electric telegraph, is due to a young countryman of our own, Mr. Graham Bell, of Edinburgh and Montreal, and Boston, now becoming a naturalised citizen of the United States. Who can but admire the hardihood of invention which devised such very slight means to realise the mathematical conception that, if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of its current must vary continuously and as nearly as may be in simple proportion to the velocity of a particle of air engaged in constituting the sound?

The Patent Museum of Washington, an institution of which the nation is justly proud, and the beneficent working of the United States patent laws, deserve notice in the section of the British Association concerned with branches of science to which nine-tenths of all the useful patents of the world owe their foundations. I was much struck with the prevalence of patented inventions in the Exhibition: it seemed to me that every good thing deserving a patent was patented. I asked one inventor of a very good invention "Why don't you patent it in England?" He answered, "The conditions in England are too onerous." We certainly are far behind America's wisdom in this respect. If Europe does not amend its patent laws (England in the opposite direction to that proposed in the Bills before the last two sessions of Parliament) America will speedily become the nursery of useful inventions for the world.

I should tell you also of "Old Prob's" weather warnings, which cost the nation 250,000 dollars a year; money well spent say the western farmers, and not they alone: in this the whole people of the United States are agreed, and though Democrats or Republicans playing the "economical ticket" may for half a session stop the appropriations for even the United States Coast Survey, no one would for a moment think of proposing to starve "Old Prob;" and now that 80 per cent. of his probabilities have proved true, and General Myers has for a month back ceased to call his daily forecasts "probabilities" and has begun to call them indications, what will the western farmers call him this time next year?

And the United States Naval Observatory, full of the very highest science, under the command of Admiral Davis! If, to get on to precession and nutation, I had resolved to omit telling you that I had there, in an instrument for measuring photographs of the transit of Venus—shown me by Prof. Harkness, a young Scotsman attracted into the United States Naval Service—seen for the first time in an astronomical observatory a geometrical slide, the verdict on the disaster on board the *Thunderer*, published while I am writing this address, forbids me to keep any such resolution, and compels me to put the question, Is there in the British Navy, or in a British steamer, or in a British land boiler another safety-valve so constructed that by any possibility, at any temperature, or under any stress it can jam? and to say that if there is it must be instantly corrected or removed.

I ought to speak to you, too, of the already venerable Harvard University, the Cambridge of America, and of the Technological Institute of Boston, created by William Rogers, brother of my late colleague in this university (Glasgow), Henry Rogers, and of the Johns Hopkins University of Baltimore, which with its youthful vigour has torn Sylvester from us, has utilised the genius and working power of Roland for experimental research, and three days after my arrival in America, sent for the young Porter Poinier to make him a Fellow. But he was on his death-bed in New York "begging his physicians to keep him alive just to finish his book, and then he would be willing to go." Of his book, "Thermodynamics," we may hope to see at least a part, for much of the manuscript, and good and able friends to edit it, are left; but the appointment to a Fellowship in the Johns Hopkins University came a day too late to gratify his noble ambition.

But the stimulus of intercourse with American scientific men left no place in my mind for framing, or attempting to frame a report on American science. Disturbed by Newcomb's suspicions of the earth's irregularities as a Time-keeper, I could think of nothing but precession and nutation, and tides and monsoons, and settlements of the equatorial regions, and melting of polar ice. Week after week passed before I could put down two words which I could read to you here to-day: and so I have nothing to offer you for my Address but—

Review of Evidence regarding Physical Condition of the Earth; its Internal Temperature; the Fluidity or Solidity of its Interior Substance; the Rigidity, Elasticity, Plasticity, of its External Figure; and the Permanence or Variability of its Period and Axis of Rotation.

The evidence of a high internal temperature is too well known to need any quotation of particulars at present. Suffice it to say that below the uppermost ten metres stratum of rock or soil sensibly affected by diurnal and annual variations of temperature, there is generally found a gradual increase of temperature downwards, approximating roughly, in ordinary localities, to an average rate of 1° C. per thirty metres of descent, but much greater in the neighbourhood of active volcanoes, and certain other special localities of comparatively small area, where hot springs and, perhaps, also, sulphurous vapours prove an intimate relationship to volcanic quality. It is worthy of remark in passing, that, so far as we know at present, there are no localities of exceptionally *small* rate of augmentation of underground temperature, and none where temperature diminishes at any time through any considerable depth downwards below the stratum sensibly influenced by summer heat and winter cold. Any considerable area of the earth of, say, not less than a kilometre in any horizontal diameter, which for several thousand years had been covered by snow or ice, and from which the ice had melted away and left an average surface temperature of 13°, would during nine hundred years, show a decreasing temperature for some depth down from the surface: and thirty-six hundred years after the clearing away of the ice would still show residual effect of the ancient cold, in a half rate of augmen-

tation of temperature downwards in the upper strata, gradually increasing to the whole normal rate which would be sensibly reached at a depth of 600 metres.

By a simple effort of geological calculus it has been estimated that 1° per 30 metres gives 1000° per 30,000 metres, and 3333° per 100 kilometres. This arithmetical result is unchallengeable, but what of the physical conclusion drawn from it with marvellous frequency and pertinacity that at depths of from 50 to 100 kilometres the temperatures are so high as to melt all substances composing the earth's upper crust? It has been remarked, indeed, that if observation showed any diminution or augmentation of the rate of increase of underground temperature in great depths, it would not be right to reckon on the uniform rate of 1° per 30 metres, or thereabouts, down to 30 or 60 or 100 kilometres. "But observation has shown nothing of the kind, and therefore surely it is most consonant with inductive philosophy to admit no great deviation in any part of the earth's solid crust from the rate of increase proved by observation as far as the greatest depths to which we have reached!" Now I have to remark upon this argument that the greatest depth to which we have reached in observations of underground temperature is scarcely one kilometre, and that, if a 10 per cent. diminution of the rate of augmentation of underground temperature downwards were found at a depth of one kilometre, this would demonstrate[1] that within the last 100,000 years the upper surface of the earth must have been at a higher temperature than that now found at the depth of one kilometre. Such a result is to be thought to be found by observation in places which have been overflown by lava in the memory of man, or a few thousand years farther back; but if without going deeper than a kilometre a 10 per cent. diminution of the rate of increase of temperature downwards were found for the whole earth, it would limit the whole of geological history to within 100,000 years, or, at all events, would interpose an absolute barrier against the continuous descent of life on the earth from earlier periods than 100,000 years ago. Therefore, although search in particular localities for a diminution of the rate of augmentation of underground temperature in depths of less than a kilometre may be of intense interest, as helping us to fix the dates of extinct volcanic actions which have taken place within 100 000 years or so, we know enough from thoroughly sure geological evidence not to expect to find it, except in particular localities, and to feel quite sure that we shall not find it under any considerable portion of the earth's surface. If we admit as possible any such discontinuity within 900,000 years, we might be prepared to find a sensible diminution of the rate at three kilometres' depth; but not at anything less than 30 kilometres if geologists validly claim as much as 100,000,000 of years for the length of the time with which their science is concerned. Now this implies a temperature of 1000° C. at the depth of 30 kilometres, allows something less than 2000° for the temperature at 60 kilometres, and does not require much more than 4,000° C. at any depth, however great; but does require at the greatest depths a temperature of at all events not less than about 4000° C. It would not take much "hurrying up" of the actions with which they are concerned, to satisfy geologists with the more moderate estimate of 50,000,000 of years. This would imply at least about 3000° C. for the limiting temperature at great depths. If the actual substance of the earth, whatever it may be, rocky or metallic, at depths of from 60 to 100 kilometres, under the pressure actually there experienced by it can be solid at temperatures of from 3000° to 4000°, then we may hold the former estimate (90,000,000) to be as probable as the latter (50,000,000) so far as evidence from underground temperature can guide us. If 4000° would melt the earth's substance at a depth of 100 kilometres, we must reject the former estimate, though we might still admit the latter; if 3000 would melt the substance at a depth of 60 kilometres, we should be compelled to conclude that 50,000,000 of years is an over-estimate. Whatever may be its age, we may be quite sure the earth is solid in its interior; not, I admit, throughout its whole volume, for there certainly are spaces in volcanic regions occupied by liquid lava; but whatever portion of the whole mass is liquid, whether the water of the ocean or melted matter in the interior, these portions are small in comparison with the whole, and we must utterly reject any geological hypothesis which, whether for explaining underground heat or ancient upheavals and subsidences of the solid crust, or earthquakes, or existing volcanoes, assumes the solid earth to be a shell of 30, or 100, or 500, or 1,000 kilometres thickness, resting on an interior liquid mass.

This conclusion was first arrived at by Hopkins, who may therefore properly be called the discoverer of the earth's solidity. He was led to it by consideration of the phenomena of precession and nutation, and gave it as shown to be highly probable, if not absolutely demonstrated, by his confessedly imperfect and tentative investigation. But a rigorous application of the perfect hydrodynamical equations leads still more decidedly to the same conclusion.

I am able to say this to you now in consequence of the conversation with Professor Newcomb to which I have already alluded. Admitting fully my evidence for the rigidity of the earth from the tides, he doubted the argument from precession and nutation. Trying to recollect what I had written on it fourteen years ago in a paper on the Rigidity of the Earth, published in the *Transactions* of the Royal Society, my conscience smote me, and I could only stammer out that I had convinced myself that so and so, and so and so, at which I had arrived by a non-mathematical short cut, were true. He hinted that viscosity might suffice to render precession and nutation the same as if the earth were rigid, and so vitiate the argument for rigidity. This, I could not for a moment admit any more than when it was first put forward by Delaunay; but doubt entered my mind regarding the so and so, and so and so, and I had not completed the night journey to Philadelphia which hurried me away from our unfinished discussion before I had convinced myself that they were grievously wrong. So now I must request as a favour that each one of you on going home will instantly turn up his or her copies of the *Transactions* of the Royal Society for 1862, and of Thomson and Tait's 'Natural Philosophy,' vol. i., and draw the pen through §§ 22, 23 of my paper on the 'Rigidity of the Earth' in the former, and through everything in §§ 847, 849 of the latter, which refers to the effect on precession and nutation of an elastic yielding of the earth's surface.

When these passages were written I knew little or nothing of vortex motion, and until my attention was recalled to it by Prof. Newcomb, I had never once thought of the subject in the light thrown upon it by the theory of the quasi rigidity induced in a liquid by vortex motion which has occupied me so much. With this fresh light a little consideration sufficed to show me that (although the old obvious conclusion is of course true, that if the inner boundary of the imagined rigid shell of the earth were rigorously spherical, the interior liquid could experience no precessional or nutational influence from the pressure on its bounding surface, and therefore if homogeneous could have no precession or nutation at all, or if heterogeneous only as much precession and nutation as would be produced by attraction from without in virtue of non-sphericity of its surfaces of equal density, and therefore the shell would have enormously more rapid precession and nutation than it actually has—forty times as much, for instance, if the thickness of the shell is sixty kilometres) a very slight deviation of the inner surface of the shell from perfect sphericity would suffice, in virtue of the quasi-rigidity due to vortex motion, to hold back the shell from taking sensibly more precession than it would give to the liquid, and to cause the liquid (homogeneous or heterogeneous) and the shell to have sensibly the same precessional motion as if the whole constituted one rigid body; but it is only because of the very long period (26,000 years) of precession, in comparison with the period of rotation (one day), that a very slight deviation from sphericity would suffice to cause the whole to move as if it were a rigid body. A little further consideration showed me—

(1) That an ellipticity of inner surface equal to $\frac{1}{26000 \times 365}$ would be too small, but that an ellipticity of one or two hundred times this amount would not be too small, to compel approximate equality of precession throughout liquid and shell.

(2) That with an ellipticity of interior surface equal to $\frac{1}{300}$, if the precessional motive were 26,000 times as great as it is, the motion of the liquid would be very different from that of a rigid mass rigidly connected with the shell.

(3) That with the actual forces and the supposed interior ellipticity of $\frac{1}{300}$ the lunar nineteen-yearly nutation might be affected to about five per cent. of its amount by interior liquidity.

(4) Lastly, that the lunar semi-annual nutation must be largely,

[1] For proof of this and following statements regarding Underground Heat I refer to "Secular Cooling of the Earth," *Transactions* of the Royal Society of Edinburgh, 1862, and Thomson and Tait's "Natural Philosophy," App. D.

and the lunar fortnightly nutation enormously, affected by interior liquidity.

But although so much could be foreseen readily enough, I found it impossible to discover, without thorough mathematical investigation, what might be the characters and amounts of the deviations from a rigid body's motion which the several cases of precession and nutation contemplated would present. The investigation, limited to the case of a homogeneous liquid enclosed in an ellipsoidal shell, has brought out results which I confess have greatly surprised me. When the interior ellipticity of the shell is just too small, or the periodic speed of the disturbance just too great to allow the motion of the whole to be sensibly that of a rigid body, the deviation first sensible renders the precessional or nutational motion of the shell smaller than if the whole were rigid, instead of greater, as I expected. The amount of this difference bears the same proportion to the actual precession or nutation as the fraction measuring the periodic speed of the disturbance (in terms of the period of rotation as unity) bears to the fraction measuring the interior ellipticity of the shell; and it is remarkable that this result is independent of the thickness of the shell, assumed however to be small in proportion to the earth's radius. Thus in the case of precession the effect of interior liquidity would be to diminish the periodic speed of the precession in the proportion stated; in other words, it would add to the precessional period a number of days equal to the multiple of the rotational period equal to the number whose reciprocal measures the ellipticity. Thus in the actual case of the earth if we still take $\frac{1}{300}$ as the ellipticity of the inner boundary of the supposed rigid shell, the effect would be to augment by 300 days the precessional period of 2,600 years, or to diminish by about $\frac{1}{600}$″ the annual precession of about 51″ an effect which I need not say would be wholly insensible. But on the lunar nutation of 18·6 years period the effect of interior liquidity would be quite sensible; 18·6 years being 23 times 300 days, the effect would be to diminish the axes of the ellipse which the earth's pole describes in this period each by $\frac{1}{23}$ of its own amount. The semi-axes of this ellipse calculated on the theory of perfect rigidity from the very accurately known amount of precession and the fairly accurate knowledge which we have of the ratio of the lunar to the solar part of the precessional motive are 9″·22 and 6″·86, with an uncertainty not amounting to one-half per cent. on account of want of perfect accuracy in the latter part of data. If the true values were less each by $\frac{1}{23}$ of its own amount, the discrepance might have escaped detection, or might *not* have escaped detection; but certainly could be found if looked for. So far nothing can be considered as absolutely proved with reference to the interior solidity of the earth from precession and nutation; but now think of the solar semi-annual and the lunar fortnightly nutations. The period of each of these is less than 300 days. Now the hydrodynamical theory shows that irrespectively of the thickness of the shell, the nutation of the crust would be zero if the period of the nutational disturbance were 300 times the period of rotation (the ellipticity being $\frac{1}{300}$): if the nutational period were anything between this and a certain smaller critical value depending on the thickness of the crust, the nutation would be negative; if the period were equal to this second critical value, the nutation would be infinite: and if the period were still less, the nutation would be again positive. Farther the 183 days period of the solar nutation falls so little short of the critical 300 days, that the amount of the nutation is not sensibly influenced by the thickness of the crust—is negative and equal in absolute value to $\frac{61}{39}$ (being the reciprocal of $\frac{300}{183}-1$) times what the amount would be were the earth solid throughout. Now this amount as calculated in the Nautical Almanac makes 0″·55, and 0″·51 the semi-axes of the ellipse traced by the earth's axis round its mean position; and if the true nutation placed the earth's axis on the opposite side of an ellipse having ″ 86 and ″ 81 for its semi-axes, the discrepance could not possibly have escaped detection. But lastly, think of the lunar fortnightly nutation. Its period is $\frac{1}{20}$ of 300 days, and its amount, calculated in the Nautical Almanac on the theory of complete solidity, is such that the greater semi-axis of the approximately circular ellipse described by the pole is 0″·0325. Were the crust infinitely thin this nutation would be negative, but its amount nineteen times that corresponding to solidity. This would make the greater semi-axis of the approximately circular ellipse described by the pole amount to 19 × 0″·0885, which is 1″·7. It would be negative and of some amount between 1″·7 and infinity, if the thickness of the crust were anything from zero to 120 kilometres. This conclusion is absolutely decisive against the geological hypothesis of a thin rigid shell full of liquid.

But interesting in a dynamical point of view as Hopkins's problem is, it cannot afford a decisive argument against the earth's interior liquidity. It assumes the crust to be perfectly stiff and unyielding in its figure. This of course it cannot be, because no material is infinitely rigid; but, composed of rock and possibly of continuous metal in the great depths, may the crust not as a whole be stiff enough to practically fulfil the condition of unyieldingness? No; decidedly it could not: on the contrary, were it of continuous steel and 500 kilometres thick, it would yield very nearly as much as if it were india rubber, to the deforming influences of centrifugal force and of the sun's and moon's attractions. Now, although the full problem of precession and nutation, and what is now necessarily included in it—tides, in a continuous revolving liquid spheroid, whether homogeneous or heterogeneous, has not yet been coherently worked out, I think I see far enough towards a complete solution to say that precession and nutations will be practically the same in it as in a solid globe, and that the tides will be practically the same as those of the equilibrium theory. From this it follows that precession and nutations of the solid crust, with the practically perfect flexibility which it would have even though it were 100 kilometres thick and as stiff as steel, would be sensibly the same as if the whole earth from surface to centre were solid and perfectly stiff. Hence precession and nutations yield nothing to be said against such hypotheses as that of Darwin,[1] that the earth as a whole takes approximately the figure due to gravity and centrifugal force, because of the fluidity of the interior and the flexibility of the crust. But alas for this "attractive sensational idea that a molten interior to the globe underlies a thin superficial crust; its surface agitated by tidal waves and flowing freely towards any issue that may here and there be opened for its outward escape," as Poulett Scrope called it! the solid crust would yield so freely to the deforming influence of sun and moon that it would simply carry the waters of the ocean up and down with it, and there would be no sensible tidal rise and fall of water relatively to land.

The state of the case is shortly thus:—The hypothesis of a perfectly rigid crust containing liquid violates physics by assuming preternaturally rigid matter and violates dynamical astronomy in the solar semi-annual and lunar fortnightly nutations; but tidal theory has nothing to say against it. On the other hand the tides decide against any crust flexible enough to perform the nutations correctly with a liquid interior, or as flexible as the crust must be unless of preternaturally rigid matter.

But now thrice to slay the slain; suppose the earth this moment to be a thin crust of rock or metal resting on liquid matter. Its equilibrium would be unstable! And what of the upheavals and subsidences? They would be strikingly analogous to those of a ship which has been rammed: one portion of crust up and another down, and then all down. I may say with almost perfect certainty, that, whatever may be the relative densities of rock, solid and melted, at or about the temperature of liquefaction, it is, I think, quite certain that cold solid rock is denser than hot melted rock: and no possible degree of rigidity in the crust could prevent it from breaking in pieces and sinking wholly below the liquid lava. Something like this may have gone on and probably did go on for thousands of years after solidification commenced; surface portions of the melted material losing heat, freezing, sinking immediately, or growing to thicknesses of a few metres when the surface would be cool and the whole solid dense enough to sink. "This process must go on until the sunk portions of crust build up from the bottom a sufficiently close-ribbed skeleton or frame, to allow fresh incrustations to remain bridging across the now small areas of lava, pools, or lakes.

"In the honey-combed solid and liquid mass thus formed, there must be a continual tendency for the liquid, in consequence of its less specific gravity, to work its way up; whether by masses of solid falling from the roofs of vesicles or tunnels, and causing earthquake shocks, or by the roof breaking quite through when very thin, so as to cause two such hollows to unite or the liquid of any of them to flow out freely over the outer surface of the earth; or by gradual subsidence of the solid owing to the thermodynamic melting, which portions of it under intense stress must experience according to my brother's theory. The results which must follow from this tendency seem sufficiently great and

[1] "Observations on the Parallel Roads of Glen Roy and other Parts of Lochaber in Scotland, with an Attempt to prove that they are of Marine Origin."—*Transactions* of the Royal Society for Feb. 1839, p. 81.

various to account for all that we learn from geological evidence of earthquakes, of upheavals and subsidences of solid, and of eruptions of melted rock." [1]

Leaving altogether now the hypothesis of a hollow shell filled with liquid, we must still face the question, how much does the earth, solid throughout, except small cavities or vesicles filled with liquid, yield to the deforming (or tide-generating) influences of sun and moon? This question can only be answered by observation. A single infinitely accurate spirit-level or plummet far enough away from the sea to be not sensibly affected by the attraction of the rising and falling water, would enable us to find the answer. Observe by level or plummet the changes of direction of apparent gravity relatively to an object rigidly connected with the earth, and compare these changes with what they would be were the earth perfectly rigid, according to the known masses and distances of sun and moon. The discrepance, if any is found, would show distortion of the earth, and would afford data for determining the dimensions of the elliptic spheroid into which a non-rotating globular mass of the same dimensions and elasticity as the earth would be distorted by centrifugal force if set in rotation, or by tide-generating influence of sun or moon. The effect on the plumb-line of the lunar tide-generating influence is to deflect it towards or from the point of the horizon nearest to the moon, according as the moon is above or below the horizon. The effect is zero when the moon is on the horizon or overhead, and is greatest in either direction when the moon is 45° above or below the horizon. When this greatest value is reached, the plummet is drawn from its mean position through a space equal to $\frac{1}{12000000}$ of the length of the thread. No ordinary plummet or spirit-level could give any perceptible indication whatever of this effect; and to measure its amount it would be necessary to be able to observe angles as small as $\frac{1}{120000000}$ of the radian, or about $\frac{1}{600}''$. Siemens' beautiful hydrostatical multiplying level may probably supply the means for doing this. Otherwise at present no apparatus exists within small compass by which it could be done. A submerged water-pipe of considerable length, say twelve kilometres, with its two ends turned up and open might answer. Suppose, for example, the tube to lie North and South, and its two ends to open into two small cisterns, one of them, the southern, for example, of half a decimetre diameter (to escape disturbance from capillary attraction); and the other of two or three decimetres diameter (so as to throw nearly the whole rise and fall into the smaller cistern). For simplicity suppose the time of observation to be when the moon's declination is zero. The water in the smaller or southern cistern will rise from its lowest position to its highest position while the moon is rising to maximum altitude, and fall again after the moon crosses the meridian till she sets; and it will rise and fall again through the same range from moonset to moonrise. If the earth were perfectly rigid, and if the locality is in latitude 45°, the rise and fall would be half a millimetre on each side of the mean level; or a little short of half a millimetre if the place is within 10° north or south of latitude 45°. If the air were so absolutely quiescent during the observations as to give no varying differential pressure on the two water surfaces to the amount of $\frac{1}{100}$ millimetre of water, or $\frac{1}{1400}$ of mercury, the observation would be satisfactorily practicable, as it would not be difficult by aid of a microscope to observe the rise and fall of the water in the smaller cistern to $\frac{1}{100}$ of a millimetre; but no such quiescence of the atmosphere could be expected at any time, and it is probable that the variations of the water-level due to difference of the barometric pressure at the two ends would in all ordinary weather quite overpower the small effect of the lunar tide-generating motive. If, however, the two cisterns instead of being open to the atmosphere were connected air-tightly by a return pipe with no water in it, it is probable that the observation might be successfully made: but Siemens' level or some other apparatus on similarly small scale would probably be preferable to any elaborate method of obtaining the result by aid of very long pipes laid in the ground; and I have only called your attention to such an ideal method as leading up to the natural phenomenon of tides.

Tides in an open canal or lake of twelve kilometres length would be of just the amount which we have estimated for the cisterns connected by submerged pipe; but would be enormously more disturbed by wind and variations of atmospheric pressure. A canal or lake of 240 kilometres length, in a proper direction and in a suitable locality, would give but ten millimetres rise and fall at each end, an effect which might probably be analysed out of the much greater disturbance produced by wind and differences of barometric pressure; but no open liquid level short of the *ingens æquor*, the ocean, will probably be found so well adapted as it for measuring the absolute value of the disturbance produced on terrestrial gravity by the lunar and solar tide generating motive. But observations of the diurnal and semi-diurnal tides in the ocean, do not (as they would on smaller and quicker levels) suffice for this purpose, because their amounts differ enormously from the equilibrium values on account of the smallness of their periods in comparison with the periods of any of the grave enough modes of free vibration of the ocean as a whole. On the other hand, the lunar fortnightly declinational and the lunar monthly elliptic and the solar semi-annual and annual elliptic tides have their periods so long that their amounts must certainly be very approximately equal to the equilibrium values.

But there are large annual and semi-annual changes of sea level, probably both differential on account of wind and differences of barometric pressure and differences of temperature of the water, and absolute depending on rain-fall and the melting away of snow and return evaporation, which altogether swamp the small semi-annual and annual tides due to the sun's attraction. Happily, however, for our object there is no meteorological or other disturbing cause which produces periodic changes of sea level in either the fortnightly declinational or the monthly elliptic period; and the lunar gravitational tides in these periods are therefore to be carefully investigated in order that we may obtain the answer to the interesting question, how much does the earth as an elastic spheroid yield to the tide-generating influence of sun or moon? Hitherto in the British Association Committee's reductions of Tidal Observations we have not succeeded in obtaining any trustworthy indications of either of these tides. The St. George's pier landing-stage pontoon, unhappily chosen for the Liverpool tide gauge cannot be trusted for such a delicate investigation; the available funds for calculation were expended before the long-period tides for Helbre Island could be attacked, and three years of Kurrachee give our only approach to a result. Comparisons of this, with an indication of a result with calculations on West Hartlepool tides, conducted with the assistance of a grant from the Royal Society, seem to show possibly no sensible yielding, or perhaps, more probably some degree of yielding, of the earth's figure. The absence from all the results of any indication of a 18·6 yearly tide (according to the same law as the other long-period tides) is not easily explained without assuming or admitting a considerable degree of yielding.

Closely connected with the question of the earth's rigidity, and of as great scientific interest and even of greater practical moment, is the question—how nearly accurate is the earth as a time-keeper? and another of, at all events, equal scientific interest—how about the permanence of the earth's axis of rotation?

Peters and Maxwell, about thirty-five and twenty-five years ago, separately raised the question, how much does the earth's axis of rotation deviate from being a principal axis of inertia? and pointed out that an answer to this question is to be obtained by looking for a variation in latitude of any or every place on the earth's surface in a period of 306 days. The model before you illustrates the travelling round of the instantaneous axis relatively to the earth in an approximately circular cone whose axis is the principal axis of inertia, and relatively to space in a cone round a fixed axis. In the model, the former of these cones, fixed relatively to the earth, rolls internally on the latter, supposed to be fixed in space. Peters gave a minute investigation of observations at Pulkova in the years 1841–42, which seemed to indicate at that time a deviation amounting to about $\frac{3}{40}''$ of the axis of rotation from the principal axis. Maxwell, from Greenwich observations of the years 1851–1854, found seeming indications of a very slight deviation—something less than half a second—but differing altogether in phase from that which the deviation indicated by Peters, if real and permanent, would have produced at Maxwell's later time. On my begging Prof. Newcomb to take up the subject, he kindly did so at once, and undertook to analyse a series of observations suitable for the purpose, which had been made in the United States Naval Observatory, Washington. A few weeks later I received from him a letter referring me to a paper by Dr. Nysen, of Pulkova Observatory, in which a similar negative conclusion as to constancy of magnitude or direction in the deviation sought for is arrived at from several series of the Pulkova observations between the

[1] "Secular Cooling of the Earth." *Transactions* of the Royal Society of Edinburgh, 1862 (W. Thomson), and Thomson and Tait's "Natural Philosophy," §§ (*ee*), (*ff*).

years 1842 and 1872, and containing the following statement of his conclusions:—

"The investigation of the ten month period of latitude from the Washington prime vertical observations from 1862 to 1867 is completed, indicating a co-efficient too small to be measured with certainty. The declinations with this instrument are subject to an annual period which made it necessary to discuss those of each month separately. As the series extended through a full five years, each month thus fell on five nearly equidistant points of the period. If x and y represent the co-ordinates of the axis of instantaneous rotation on June 30, 1864, then the observations of the separate months gave the following values of x and y:—

	x.	weight.	y
	$''$		$'$
January ...	0·35	10	+ 0·32
February ...	0·03	14	+ 0·09
March ...	+ 0·17	10	+ 0·16
April ...	+ 0·44	5	+ 0·05
May ...	+ 0·08	16	+ 0·02
June ...	− 0·01	14	− 0·01
July ...	0·05	14	− 0·00
August ...	− 0·24	14	+ 0·29
September...	+ 0·18	14	+ 0·21
October ...	+ 0·13	14	0·01
November..	+ 0·08	17	− 0·20
December..	− 0·08	16	0·08
Mean	$.0''·01 \pm ''·03$		$+ 0'·05 \pm '·03$

Accepting these results as real they would indicate a radius of rotation of the instantaneous axis amounting, at the earth's surface, to 5 feet and a longitude of the point in which this axis intersects the earth's surface near the north pole such that on July 11, 1864, it was 180° from Washington, or 103° east of Greenwich. The excess of the co-efficient over its probable error is so slight that this result cannot be accepted as anything more than a consequence of the unavoidable errors of observation."

From the discordant character of these results we must not, however, infer that the deviations indicated by Peters, Maxwell, and Newcomb are unreal. On the contrary any that fall within the limits of probable error of the observations ought properly to be regarded as real. There is in fact a *vera causa* in the temporary changes of sea-level due to meteorological causes, chiefly winds, and to meltings of ice in the polar regions and return evaporations, which seems amply sufficient to account for irregular deviations of from $\frac{1}{2}''$ to $\frac{1}{20}''$ of the earth's instantaneous axis from the axis of maximum inertia, or, as I ought rather to say, of the axis of maximum inertia from the instantaneous axis.

As for geological upheavals and subsidences, if on a very large scale of area, they must produce, on the period and axis of the earth's rotation, effects comparable with those produced by changes of sea-level equal to them in vertical amount. For simplicity, calculating as if the earth were of equal density throughout, I find that an upheaval of all the earth's surface in north latitude and east longitude, and south latitude and west longitude, with equal depressions in the other two quarters, amounting at greatest to 10 centimetres, and graduating regularly from the points of maximum elevation to the points of maximum depression in the middles of the four quarters, would shift the earth's axis of maximum moment of inertia through 1″ on the north side towards the meridian of 90° W. longitude, and on the south side towards the meridian of 90° E. longitude. If such a change were to take place suddenly, the earth's instantaneous axis would experience a sudden shifting of but $\frac{1}{300}''$ (which we may neglect) and then, relatively to the earth, would commence travelling, in a period of 306 days, round the fresh axis of maximum moment of inertia. The sea would be set into vibration, one ocean up and another down through a few centimetres, like water in a bath set aswing. The period of these vibrations would be from twelve to twenty-[illegible] or at most a day or two; their subsidence would be so rapid that after at most a few months they would [illegible] Then a regular 306 days' period tide of 11 centimetres from lowest to highest would be to be observed, with gradually diminishing amount from century to century, as through the dissipation of energy produced by this tide, the instantaneous axis of the earth is gradually brought into coincidence with the fresh axis of maximum moment of inertia. If we multiply these figures by 3,600, we find what would be the [illegible]lt of a similar sudden upheaval and subsidence of the earth to the extent of 360 metres above and below previous levels. It is not impossible that in the very early ages of geological history such an action as this, and the consequent 400 metres tide producing a succession of deluges every 306 days for many years may have taken place; but it seems more probable that even in the most ancient times of geological history the great world wide changes, such as the upheavals of the continents and subsidences of the ocean beds from the general level of their supposed molten origin, took place gradually through the thermo-dynamic melting of solids and the squeezing out of liquid lava from the interior to which I have already referred. A slow distortion of the earth as a whole would never produce any great angular separation between the instantaneous axis and axis of maximum moment of inertia for the time being. Considering, then, the great facts of the Himalayas and Andes, and Africa and the depths of the Atlantic, and America and the depths of the Pacific, and Australia, and considering farther the ellipticity of the equatorial section of the sea-level estimated by Capt. Clarke at about $\frac{1}{10}$ of the mean ellipticity of meridional sections of the sea-level, we need no brush from the comet's tail, a wholly chimerical cause which can never have been put forward seriously except in ignorance of elementary dynamical principles, to account for a change in the earth's axis; we need no violent convulsion producing a sudden distortion on a great scale with change of the axis of maximum moment of inertia followed by gigantic deluges; and we may not merely admit, but assert as highly probable, that the axis of maximum inertia and axis of rotation, always very near one another, may have been in ancient times very far from their present geographical position, and may have gradually shifted through ten, twenty, thirty, forty, or more degrees without, at any time, any perceptible sudden disturbance of either land or water.

Lastly, as to variations in the earth's rotational period:—You all, no doubt, know how in 1853 Adams discovered a correction to be needed in the theoretical calculation with which Laplace followed up his brilliant discovery of the dynamical explanation of an apparent acceleration of the moon's mean motion, shown by records of ancient eclipses; and how he found that when his correction was applied, the dynamical theory of the moon's motion accounted for only about half of the observed apparent acceleration; and how Delaunay in 1866 verified Adams's result, and suggested that the explanation may be a retardation of the earth's rotation by tidal friction. The conclusion is, that since March 19, 721 B.C., a day on which an eclipse of the moon was seen in Babylon, commencing "when one hour after her rising was fully passed," the earth has lost rather more than $\frac{1}{8000000}$ of her rotational velocity, or as a timekeeper, is going slower by $11\frac{1}{4}$ seconds per annum now than then. According to this rate of retardation, if uniform, the earth at the end of a century would, as a timekeeper, be found 22 seconds behind a perfect clock, rated and set to agree with her at the beginning of the century. Newcomb's subsequent investigations in the lunar theory have on the whole tended to confirm this result, but they have also brought to light some remarkable apparent irregularities in the moon's motion, which, if real, refuse to be accounted for by the gravitational theory without the influence of some unseen body or bodies passing near enough to the moon to influence her mean motion. This hypothesis Newcomb considers not so probable as that the apparent irregularities of the moon are not real and are to be accounted for by irregularities in the earth's rotational velocity. If this is the true explanation it seems that the earth was going slow from 1850 to 1862, so much as to have got behind by 7 seconds in these 12 years, and then to have begun going faster again so as to gain 8 seconds 1862 to 1872. So great an irregularity as this would require somewhat greater changes of sea-level, but not many times greater, than the British Association Committee's reductions of tidal observations for several places in different parts of the world, allow us to admit to have possibly taken place. The assumption of a fluid interior, which Newcomb suggests, and the flow of a large mass of the fluid "from equatorial regions to a position nearer the axis," is not, from what I have said to you, admissible as a probable explanation of the remarkable acceleration of rotational velocity which seems to have taken place about 1862; but happily it is not necessary. A settlement of 14 centimetres in the equatorial regions with corresponding rise of 28 centimetres at the poles, which is so slight as to be absolutely undiscoverable in astronomical observatories, and which would involve no change of sea-level absolutely disproved by reductions of tidal observations hitherto made would suffice. Such settlements must occur from time to time; and a settlement of the amount suggested might result from the diminution of centrifugal force due to 150 or 200 centuries' tidal retardation of the earth's rotational speed.

SECTION B

CHEMICAL SCIENCE

OPENING ADDRESS BY WILLIAM HENRY PERKIN, F.R.S., PRESIDENT.

THERE can be no doubt that chemistry and the allied sciences are now being recognised to a much greater extent in this country than in former years, and not only so, the workers at research, though still small in number, are more numerous than they were.

In 1868, Dr. Frankland, in his address to this section at the meeting at Norwich, commented upon the small amount of original research then being carried on in the United Kingdom, but, judging from the statistics of the Chemical Society, this state of things became even worse, for in 1868 there were forty-eight papers read before the Society, but in 1872 only twenty-two. Since then, however, there has been a considerable increase in the number, and at the Anniversary Meeting in March last it was shown that the number of communications for the session had risen to sixty six, or three times as many as in 1872.

Of course these figures only refer to the Chemical Society, but I think they may be taken as a very safe criterion of the improved state of things, though it would be very gratifying to see much greater activity.

It is also very pleasing to find that the aids to, and opportunities for, research are increasing, because it must be remembered that, in a pecuniary sense, science is far from being its own rewarder at the time its truths are being studied, although the results very often become eventually of the greatest practical value; hence the wisdom of a country encouraging scientific research.

But little, however, has been done in this direction in past years. The grants made for general science by this association and that of the Government of 1,000*l.* annually to the Royal Society being the most important.

The Chemical Society has also been in the habit of giving small grants for the purpose of assisting those engaged in chemical research. In the future, however, it will be able to do much more than hitherto. One of the original members of the society, Dr. Longstaff, offered in the early part of the year to give 1,000*l.* provided a similar sum could be raised, the united amount to be invested, and the interest applied for the encouragement of research. I am happy to state that rather more than the required sum has been raised, and it is hoped that it may be still further supplemented.

In addition to the Royal Society grant, the Government have given this year a further annual sum of 4,000*l.* Of course this is for science generally.

Mr. T. J. Phillips Jodrell has also placed at the disposal of the Royal Society the munificent sum of 6,000*l.* to be applied in any manner that they may consider for the time being most conducive to the encouragement of research in physical sciences.

When we consider how much of our science is of a physical nature, we must be grateful for this bequest, and it is to be hoped that these helps will more and more stimulate research in the United Kingdom; and if we have any hope of keeping pace with the large amount of work being now carried on in other countries we must indeed be energetic.

The employment of well trained chemists in chemical works is now becoming much more general than heretofore, especially on the Continent, where in some cases a considerable staff is employed and provided with suitable appliances, &c., for the purpose not only of attending to and perfecting the ordinary operations which are in use, but to make investigations in relation to the class of manufacture they are engaged in. A conviction of the necessity of this is gaining strength in this country, though not so quickly as might be desired; nevertheless these things are encouraging.

With reference to the progress of chemistry and what have been the fruits of research of late years, it will be impossible for me to give even a general outline, the amount of work being so large; in fact, to recount the list of investigations made during the past year would take up most of the time at my disposal.

Amongst the most interesting, perhaps, are those relating to isomerism, especially in the aromatic series of organic bodies, and it is probable that a more intimate knowledge of this subject will be found of really practical value.

As I am unable to give an account of the work done during the past year on account of its extent and diversity, I propose to refer to some of the practical results which have already accrued from organic chemistry, as a plea for the encouragement of research; and those I intend to speak of are of special interest also on account of their close connection with the textile manufactures of Great Britain. I need scarcely say I refer to the colouring matters which have been obtained from the products found in tar.

It was in 1856, now twenty years since, that this industry was commenced by the discovery of the "mauve" or "aniline purple," and it may be of interest to state that it was in Scotland in the autumn of the same year that the first experiments upon the application of this dye to the arts of dyeing and calico printing were made at Perth and Maryhill.

I need scarcely remind you of the wonderful development of this industry since then, seeing we now have from the same source colouring matters capable of producing not only all the colours of the rainbow, but their combinations. I wish now, however, briefly to refer to the date and origin of the products which have served to build up this great industry.

It was in 1825 that Faraday published in the *Philosophical Transactions* his research on the oily products separated in compressing oil gas, and described a substance he obtained from it—a volatile colourless oil, which he called bicarburetted hydrogen. Mitscherlich some years afterwards, obtained the same substance from benzoic acid, and gave it the name it bears, viz. "Benzol." This same chemist further obtained from benzol nitrobenzol, by acting upon it with nitric acid. Zinin afterwards studied the action of reducing agents upon nitrobenzol, and obtained "aniline," which he at that time called benzidam.

Again, Pelletier and Walter discovered the hydrocarbon toluol in 1837. Deville produced its nitro compound in 1841, and Hofmann and Muspratt obtained from this "toluidine," by the process used by Zinin to reduce nitrobenzol.

I might mention other names in connection with these substances, such as Runge, Unverdorben, &c., but I would now ask, did any of these chemists work at these subjects for the hope of gain? was it not rather from the love of research, and that alone? and now these products which were then practically useless, are the basis of the aniline colours. But to go further. Dobereiner a long while ago obtained from alcohol a substance which he called "light oxygen ether," now known as aldehyd. Gay Lussac produced iodide of ethyl in 1815. Dumas and Peligot discovered the corresponding substance iodide of methyl in 1835; but, as in the cases I have previously referred to, these bodies had no practical value, and were never prepared but in the laboratory. Hofmann, in his researches on the molecular constitution of the volatile organic bases, in 1850, discovered the replacement compounds of aniline containing alcohol radicals.

All these compounds have now been manufactured on the large scale, and used in the further development of the industry of these aniline colouring matters.

Other substances might be mentioned, but I think these are sufficient to show how the products of research which, when first discovered and for a long period afterwards, were of only scientific interest, at last became of great practical value; and it is evident that had not the investigations and discoveries I have referred to been made as they were solely from a love of science, no aniline colours would now be known.

The colouring matters I have hitherto spoken of are nitrogenous, and derived from benzol and its homologues; there are a few others, however, of the same origin which contain no nitrogen, but they are of secondary importance.

I now pass on to another class of colouring-matter which is obtained from anthracene, a coal tar product differing from benzol and toluol in physical characters, inasmuch as it is a magnificent crystalline solid.

The first colouring matter derived from anthracene which I wish to draw your attention to is alizarin, the principal dyeing agent found in the madder root. This substance was for a long time supposed to be related to naphthaline, inasmuch as phthalic acid can be produced from both of them; and many were the experiments made by chemists in this direction; it was not, however, until 1868 that this was proved to be a mistake, and its relationship to anthracene was discovered by Graebe and Liebermann, who succeeded in producing this coal-tar product from the natural alizarin itself.

Having obtained this important result, they turned their attention further to the subject, hoping to find some process by which alizarin could be produced from anthracene; in this they were soon successful.

The discovery of the artificial formation of alizarin was of great interest, inasmuch as it was another of those instances which have of late years become so numerous, namely, the

formation of a vegetable product artificially, but the process used by Graebe and Liebermann was of little practical value on account of the difficulty and expense of working it.

Having previously worked on anthracene derivatives, it occurred to me to make some experiments on this subject, which resulted in the discovery of a process by which the colouring-matter could be economically produced on the large scale. Messrs. Caro, Graebe, and Liebermann at about the same time obtained similar results in Germany; this was in 1869. Further investigation during the same year yielded me a new process, by which "dichloranthracene" could be used in place of the more costly product anthraquinone, which was required by the original processes. I mention this as most of the artificial alizarin used in this country up to the end of 1873, and a good deal since, has been prepared by this new process.

It was observed that when commercial artificial alizarin prepared from anthraquinone, but more especially from dichloranthracene, was used for dyeing, the colours produced differed from those dyed with madder or pure alizarin, and many persons therefore concluded that the artificial colouring-matter was not alizarin at all. This question, however, was set at rest by separating out the pure artificial alizarin from the commercial product and comparing it with the natural alizarin, when it was found to produce exactly the same colours on mordanted fabrics, to have the same composition, to give the same reactions with reagents, and to yield the same products on oxidation.

But whilst examining into this subject it was found that a second colouring matter was present in the commercial product, and in somewhat large quantities, especially when dichloranthracene had been employed in its preparation, and to this was due the difference in shade of colour referred to.

This substance, when investigated, was found to have the same composition as "purpurin," also a colouring matter found in madder, but of very little value on account of the looseness and dulness of some of the colours it produces. This new substance, being derived from anthracene, was named anthrapurpurin; unlike its isomer purpurin however, it is of great value as a colouring matter. I do not think I shall be going beyond the results of experience if I say it is of as great importance as alizarin itself; with alumina mordants it produces reds of a more scarlet or fiery hue than those from alizarin. In fact, so fine are the colours produced that, with ordinary alumina-mordants on unoiled cotton, it gives results nearly equal to Turkey red produced with madder or garancine, and I believe the rapid success of artificial alizarin was greatly due to its presence. Most of that consumed at first was for Turkey red dyeing, and the colours were so clear and brilliant that it was mostly used in combination with madder or garancin, to brighten the colours produced by these natural products.

The purple colours anthrapurpurin produces with iron mordants are bluer in shade than those of alizarin, and the blacks are very intense. Its application is practically the same as alizarin, so that they can be used in combination.

As noted just now, the commercial product called "artificial alizarin" first supplied to the consumer was always a mixture of alizarin and anthrapurpurin, and various mixtures of these two colouring-matters are still sent into the market; but owing to the investigations that have been made, and the study and attention that have been given to it by manufacturers, nearly pure alizarin and anthrapurpurin are also sent into the market, the first being known as "blue shade alizarin," and the second as red or "scarlet alizarin."

The formation of anthrapurpurin in the manufacture of alizarin may to some extent be said to have arisen from a want of knowledge of the true conditions required for the production of the latter.

It is now well known that alizarin is a dioxyanthraquinone, or, in other words, anthraquinone, in which two atoms of hydrogen are replaced by hydroxyl.

$$\underbrace{C_{14}H_8O_2}_{\text{Anthraquinone}} \qquad \underbrace{C_{14}H_6(HO)_2O_2}_{\text{Alizarin}}$$

If we want to introduce hydroxyl into a compound, there are several processes which can be used, but I will only refer to those connected with the history of this colouring matter.

The first process which I will refer to has been used by chemists for a long period. It consists in first replacing the hydrogen by bromine, and then treating the resulting body with potassic or other metallic hydrate; and according as one, two, or more atoms of hydrogen have been replaced by the bromine, so on its removal by the metal of the metallic hydrate, a compound containing a corresponding number of atoms of hydrogen replaced by hydroxyl is obtained.

Graebe and Liebermann acted upon this principle in their experiments on the artificial formation of alizarin; and as it was necessary to replace two atoms of hydrogen in anthraquinone, they first of all prepared a dibrominated derivative, called dibromanthraquinone,

$$C_{14}H_6Br_2O_2.$$

By decomposing this with potassic hydrate at a high temperature, they obtained a violet-coloured product, which, when acidified to remove the alkali, gave a yellow precipitate of alizarin,

$$C_{14}H_6(HO)_2O_2.$$

The second process I wish to speak of for the replacement of hydrogen by hydroxyl in a compound is by converting it into a sulpho-acid (usually by means of sulphuric acid), and subsequently decomposing this with potassic or other hydrate; and according as a mono- or disulpho-acid is employed, it yields on decomposition a compound with one or two atoms of hydrogen replaced by hydroxyl.

The discovery of sulpho acids of anthraquinone, and their use in place of the brominated derivative originally employed by Graebe and Liebermann, constituted the great improvement in the manufacture of alizarin already referred to.

From what has just been stated, it was naturally supposed that a disulpho acid of anthraquinone would be required to produce alizarin; and this was believed to be the case for some time; but further experiments have proved it to be a mistake, and shown that the monosulpho acid is required to produce alizarin, the disulpho-acid yielding anthrapurpurin.

But how are we to explain this apparent anomaly? It would take up too much time to enter into a discussion respecting the constitution of the sulpho acids of anthraquinone in reference to the position of the HSO_3 groups. I will therefore confine my remarks to their decomposition.

Monosulphoanthraquinonic acid,

$$C_{14}H_7(HSO_3)O_2,$$

when heated strongly with caustic alkali, as potassic or sodic hydrate, decomposes in the ordinary way, and we get "monoxyanthraquinone,"

$$C_{14}H_7(HO)O_2,$$

which is a yellow body possessing no dyeing properties. On further treating this, however, with caustic alkali it changes, being oxidised, and yields alizarin,

$$C_{14}H_6(HO)_2O_2.$$

Disulphoanthraquinonic acid,

$$C_{14}H_6(HSO_3)_2O_2,$$

when subjected to the influence of caustic alkali, at first changes into an intermediate acid,

$$C_{14}H_6(HO)(HSO_3)O_2,$$

and then into a dioxyanthraquinone,

$$C_{14}H_6(HO)_2O_2,$$

now known as "isoanthraflavic acid"—a substance having the same composition as alizarin, but being only an isomer of that body, and possessing no affinity for mordants; like monoxyanthraquinone, however, when further heated with alkali, it becomes oxidised and yields a colouring-matter, which is "anthrapurpurin,"

$$C_{14}H_5(HO)_3O_2.$$

Looking at these reactions, it appears rather remarkable that Graebe and Liebermann should have succeeded in preparing alizarin from dibromanthraquinone. It can only be explained on the assumption that the hydrogen atoms replaced in the disulpho-acid are different in position to those replaced in the dibromanthraquinone; and of course it is possible that a disulpho-acid isomeric with that now known may be discovered that will yield alizarin as a first product on treatment with alkali.

In the reaction which takes place when monoxyanthraquinone or isoanthraflavic acid become oxidised and change into alizarin and anthrapurpurin, nascent hydrogen is formed, and this causes a reverse action to take place, ordinary anthraquinone or its hydrogen derivative, being formed, and a loss of colouring-matter resulting. A small amount of potassic chlorate is now used with the caustic alkali, just sufficient to overcome the

reducing action which has resulted in an increased yield of colouring-matter, the percentage obtained being now not very much below the theoretical quantity.

When the process for making commercial artificial alizarin by treating anthraquinone with sulphuric acid was first adopted, the product from that treatment was a mixture of the mono- and disulpho-acids of anthraquinone. Consequently the colouring-matter prepared in this manner was a mixture of alizarin and anthrapurpurin; and the reason why dichloranthracene, when used in place of anthraquinone, yields a product very rich in anthrapurpurin, is on account of the readiness with which it forms a disulpho-acid of dichloranthracene which afterwards changes into the disulpho-acid of anthraquinone.

At first it was supposed by many that the quantity of coal-tar produced would not yield a sufficient supply of anthracene for the manufacture of artificial alizarin. Experience has, however, proved that this supposition was groundless, as now the supply is greater than the demand.

Moreover some very interesting experiments have lately been made, by which anthraquinone and its derivatives have been obtained without the use of anthracene. The most interesting are those in which phthalic anhydride is employed with benzolic derivatives; for example, this anhydride gives with hydroquinone a colouring-matter having the same composition, as well as most of the other properties of alizarin. It is called quinizarin. Baeyer and Caro have also obtained from phthalic anhydride and phenol oxyanthraquinone; and by using pyrocatechin in place of phenol they got alizarin itself.

Although these products have not been obtained in sufficient quantities by these processes to be of any practical value, we do not know what further research may do. Already one of the substances used is being prepared on the large scale for the manufacture of that beautiful colouring-matter "eosine;" I refer to phthalic anhydride.

Now with reference to the origin of the products which are used for the manufacture of artificial alizarin. We find the first researches made in reference to anthracene were by Dumas and Laurent in 1832; subsequently Laurent further worked upon this subject, and obtained, by the oxidation of this hydrocarbon, a substance which he called anthracenuse; he also obtained dichloranthracene. Dr. Anderson also made an investigation on anthracene and its compounds in 1863, and assigned to it its correct formula; he re-examined its oxidation product, which Laurent called anthracenuse, and named it oxyanthracene, this substance we now know as anthraquinone.

All these substances were without any practical value until 1868; but we now find them of the greatest importance, and used in very large quantities.

But to bring out more clearly the practical importance of these fruits of research, it will be well perhaps to see what has been their influence on the colouring-matters which were in use before them, and also the extent of their present consumption.

The influence of the so-called aniline colours on the old colouring matters, has been remarkably small. It is true that at first magenta had a depreciating influence upon cochineal; but this has passed away, and now the consumption of that dye is as great as ever; certainly its price is much lower than it used to be; but this is due to a variety of causes, especially the great increase in the cultivation of the insect at Teneriffe. And perhaps this want of influence is not so very remarkable, when we consider the aniline colours are entirely new products, differing in composition and properties from the old colouring-matters, &c., and therefore could only displace them to a certain extent.

But whilst this is the case the aniline colours have been more and more used, until at present it is computed that their annual sale in the United Kingdom and on the Continent exceeds 2,000,000*l*. This is probably due to new applications and increase of trade.

When, however, we come to consider the influence of the anthracene colours alizarin and anthrapurpurin, more generally known as "artificial alizarin," we find we have a very different tale to tell.

Here, in the case of alizarin, we have a competition not between two colouring-matters, but the same from different sources; the old source being madder-root, the new one coal-tar. And when we introduce the consideration of anthrapurpurin, which produces such magnificent reds, much brighter than alizarin or ordinary purpurin, we see we have not only a replacement but an improvement, so that these new colouring-matters throw the old ones into the shade. The products being purer, the clearing processes for goods dyed with them are also necessarily easier and simpler.

It will be interesting to examine into the statistics of the madder and garancine trade in a brief manner, to see what has been the influence of artificial alizarin on their consumption. The following figures are mostly calculated from the Board of Trade returns.

During the ten years immediately preceding the introduction of artificial alizarin the average annual imports of madder into the United Kingdom were 15,292 tons, and of garancine 2,278 tons. Estimating the value of the former at 2*l*. 2*s*. 6*d*., and the latter at 8*l*. per cwt., which were about the average prices during that period, the annual value in round numbers was about one million sterling.

The introduction of artificial alizarin has, however, so influenced the value of madder that its price is now less than one-half; and thus a saving of over half a million sterling per annum has been effected to the manfacturers of the United Kingdom, one half of which may be put down to Glasgow.

So much for its effect in reducing prices; but what has been its influence on the consumption of these dye-stuffs?

I have already stated the average quantity of these substances imported per annum prior to the discovery of the artificial product, and will now compare it with the imports of last year and this. That for the present year of course is an estimated quantity, and calculated from the returns for the first seven months.

Average annual imports.

	1859–1860 tons	1875. tons.	1876. tons
Madder ...	15,292	5,014	3,653
Garancine ...	2,278	1,293	813

These numbers speak for themselves.

The money value, which was formerly 1,000,000*l*. per annum, is now, calculating from the estimated quantity for this year, only 138,105*l*., say 140,000*l*. taking garancine at 4*l*. per cwt. and madder at 1*l*. per cwt., prices slightly in excess of their present value.

At the present prices the cultivation of madder-roots is unremunerative, so that it is to be expected that madder growing will soon be a thing of the past, thousands of acres of land being at the same time liberated for the growth of those products we cannot produce artificially, and without which we cannot exist. The quantity of madder grown in all the madder-growing countries of the world prior to 1868 was estimated to be 70,000 tons per annum, and at the present time the artificial colour is manufactured to an extent equivalent to 50,000 tons, or more than two-thirds of the quantity grown when its cultivation had reached its highest point.

I might have referred to other subjects besides the coal-tar colours which have resulted from scientific research; but I know of no other of such interest and magnitude. From the brief history I have given we see that the origin of these colouring matters is entirely the fruit of many researches made quite independently by different chemists, who worked at them without any knowledge of their future importance; and on looking at the researches which have thus culminated in this industry, it is interesting to notice that many, if not most of them, were conducted for the purpose of elucidating some theoretical point.

These facts certainly ought to be a great encouragement to chemists, and stimulate them to greater activity. It would be very pleasing to see more work emanating from the chemical schools of the United Kingdom · and I think no student should consider his chemical curriculum finished until he has conducted an original research. The knowledge obtained by a general course of instruction is of course of very great value, but a good deal of it is carried on by rule; in research, however, we have to depend upon the exercise of our judgment, and in fact of all our faculties; and a student having once conducted even one investigation, under the guidance of an efficient director, will find that he has acquired an amount of experience and knowledge which will be of the greatest value to him afterwards.

It is hoped these remarks will encourage young chemists patiently and earnestly to work at whatever subject they may undertake, knowing that their results, although sometimes apparently only of small interest, may contain the germ of something of great scientific or practical importance, or may, like a keystone in an arch, complete some subject which before was fragmentary and useless.

SECTION C

GEOLOGY

THE Duke of Argyll read a paper *On the Physical Structure of the Highlands, in connection with their Geological History*. He said:—The questions dealt with by geological science have now become so vast and various that no one district of country can be expected to furnish illustrations of more than a very few of them. The West of Scotland, in the capital of which we are now assembled, is not rich in deposits which illustrate the passage of animal life from the types which have become extinct to those which are of more modern origin and which still survive. No bone caverns have been discovered of importance, and, with one exception, even our river gravels and estuarine deposits have not been especially productive. That exception is, indeed, a feature. It was in this valley of the Clyde that the late Mr. Smith, of Jordan hill, first discovered those indications of Antarctic climate recently prevailing, which have ever since constituted a large and important branch of geological inquiry, and the full interpretation of which still presents some of the most curious problems with which we have to deal. But our Palæozoic areas, except the Coal Measures, are to a large extent singularly unfossiliferous; neither the Scottish Oolite nor Lias have yielded any remarkable additions to the curious fauna of which in England and elsewhere they have yielded abundant specimens. But, on the other hand, perhaps no area of country of equal extent in any quarter of the world presents more remarkable phenomena than the West of Scotland in connection with those causes of geological change which have determined the form of the earth's surface, and have given to its physical geography those features of variety and beauty which are the increasing delight of civilised and instructed men.

We cannot descend the course of this river Clyde to the noble estuary in which it ends, without having presented to us mountain outlines and an intricate distribution of sea and land which raise questions of the highest interest, and of the greatest difficulty. From the northern shores of that estuary to Cape Wrath, in Sutherland, the country is occupied mainly by rocks of the Silurian age, but so highly crystalline as to be almost wholly destitute of fossils, and so upheaved, twisted, contorted, and folded into a thousand different positions that, except in one great section, it is most difficult to trace any persistent succession of beds. It is one great series of billowy undulation traversed by glens and valleys, some of which are high above the level of the sea, but many of which are now so deeply submerged that the ocean is admitted far into the bosom of the hills. These glens and valleys lie in many different directions, but there are so many with one prevalent direction as to give a general character to the whole—a direction from north-east to south-west, or parallel to the prevalent strike of the Silurian rocks. The slopes of the hills and mountains are not by any means wholly without relation to geological structure, because in a thousand cases the sloping outlines will be found to be determined by the inclination of the beds, and the precipitous or steeper outlines to be determined by the upturned or broken edges. In like manner there are cases where a crumpled or knotted outline is the index of beds deeply folded and counteracted along anticlinal axes; but, nevertheless, there are also innumerable cases where no such relation can be traced, where the mountains seem to have been cut off some solid mass, all the rest of which has been removed by some agency which left these great fragments standing by themselves, and of which the contours cut across the lines of the structure at every variety of angle.

Along the whole western face of this country it is guarded from the open ocean by an archipelago of islands, some of which are separated from the mainland by submerged valleys no broader than those which separate one hill from another in the inland glens. Many of these islands are wholly occupied by the *débris* and the outbursts of extinct volcanoes. The mountains which are thus composed bear in many cases the characteristic forms of lava streams, but many others are not readily distinguishable in outline from the mountains of wholly different material which are near them. They reach the same general average level of height, here and there rising into peaks very similar to others of a widely different age and of a widely different material. Moreover, all the islands partake largely of the general character of the mainland in having their deeper valleys submerged, and in being thus deeply indented by arms of the sea similar to those which give its peculiar outline to the adjacent coasts.

It may serve to bring more vividly before you the facts of the physical geography of the country (for which it is one of the duties of geologists to account if they can) if I give you some statistical facts affecting the single county of Argyll, which begins on the northern shore of the Firth of Clyde. Following the coast line of that county from the head of Loch Long, which is its southern and eastern boundary, to Loch Aylort, which is its northern and western boundary, and, including its islands, we find it measures no less than 2,289 miles in length, of which about 840 represent the sinuosities of the mainland, and 1,449 represent the coast line of its larger islands. There are, besides, valleys, which are now inland, and are occupied by fresh water lakes, which evidently at a recent period were arms of the sea, and these represent a further line of coast measuring 276 miles. There are eleven principal arms of the sea, each of them measuring from one to thirty-six miles in length. Two of these arms of the sea exceed the 100 fathoms line in depth—Loch Fyne and the Linnhe Loch; and it is very remarkable that these deep soundings do not occur near the points where these lochs join the more open sea, but, on the contrary, far up their course or bed among the mountains. The ridges dividing these and the other valleys vary in elevation from hills of very moderate height to the ranges of Cruachan, which immediately beyond the boundary of the country culminates in Ben Nevis, which rears its head almost on a level with Ben Macdhui, now ascertained to be the highest summit in the British Isles. But no statistics can give an idea of the intricacy with which sea and land are interfolded on the western coasts comparable with that which is gained by some of the many beautiful views that abound on the heights in the vicinity of Oban, whence the visitor can command the entrance of Loch Etive, with the course for many miles of the Linnhe Loch, of the Sound of Mull, the Sound of Kerrera, and the Firth of Lorne.

Now, the question naturally arises—to what geological ages and to what geological causes do we owe in its main features this curious distribution of land and sea? I say in its main features, because, of course, the more superficial sculpturing of every mountainous country is undergoing incessant modification, and this modification may have been, and probably has been, very considerable indeed, in the times which, geologically speaking, belong to the existing age; but the question I put has reference to the epoch of past time when the main outlines of hill and valley were determined, when the great mass of the country (which has been, I believe, correctly identified as composed of metamorphosed Silurian beds) was elevated into the various mountain chains which now constitute its characteristic features.

If the question had been asked some five and twenty years ago I should have said that the evidence pointed to an age of great geological antiquity, for the central group of highland mountains was in some shape like that in which we see them. All round the edges of the country there are the remains of the Old Red Sandstone, which often fit into the contour of the valleys and have left fragments in nooks and recesses of the hills. It would almost seem as if they had been the shores of the seas and great lakes in which that great system of deposit was laid down, and that they had lifted their heads above those waters in forms not wholly unlike those in which we now see them. The total absence over almost the whole country of any other or later rocks, the absence among the *débris* of any material other than that of which the hills are themselves composed, would seem to confirm the same general conclusion. Some doubt, however, may seem to have been thrown on this conclusion, since it has become certain that it cannot be true of, at least, one district of our western mountains, which is, nevertheless, closely related to all the rest, having the same general elevation, partaking of the same general trend of coast lines, cut up by similar valleys, and fitting into the same contours of denudation.

The district to which I refer is that of the volcanic islands which stretch from the south end of Mull to the north end of Skye. Since the discovery which I was fortunate enough to make in 1851 of the leaf-beds in Mull, it has become clearly ascertained that these islands are the remains of volcanoes of that geological age to which an ever-increasing interest seems to attach—that middle age of the great Tertiary division of geological time to which Lyell gave the name of Miocene. The mountains of Mull and of Eigg and of Rona and of Skye, in all their valleys and intricate lines of coast, have unquestionably an origin later than the Miocene—how much later is the question of physical geography which geologists are called to solve. It is possible, indeed, to suppose that the hills of the mainland might be of a very different age from those of the adjacent islands, and against this, until some two years ago, there would have been nothing to advance except the suspicious similarity and adjust-

ment between the two groups, the coincidence of their outlines, and of the way in which they had been cut and carved; but the admirable researches of Mr. Judd have, in 1874, brought one little fact to light which speaks volumes for the enormous changes which must have taken place since the volcanoes of the Miocene over a portion at least of the Highland area, and which may therefore have taken place over the whole of it. The land upon which the Miocene vegetation flourished and upon which the lava streams of the volcanoes were poured out, seems to have been for the most part a land consisting of Cretaceous and Secondary rocks. The fragments of that country which remain are generally consistent with the supposition that they were deposited in a sea which washed round the bases of the Highland mountains, but which never covered them.

Like the fragments of the Old Red Sandstone, the remains of the Secondary rocks lie along the margins and fringes of the Silurian hills; but Mr. Judd has made the startling discovery of an outlier of the whole series of the Secondary rocks, including representative beds of the Trias, Lias, Green Sand, and Chalk, together with deposits, probably lacustrine—all lying on the top of one of the mountains of metamorphic gneiss which constitute the district of Morven. This fragment has been preserved by having been covered by a sheet of lava from some great neighbouring volcanic centre, the position of which is indicated by Ben More in Mull; but the mass of volcanic trap which was covered up and preserved this relic of the Cretaceous land is itself a fragment occupying the top of a mountain of gneiss separated from the remainder of the sheet of lava to which it belongs by deep valleys precisely similar to those which divide the hills from each other throughout the whole area of the Highlands. The position of an outlier of the Cretaceous rocks on the summit of a mountain of gneiss is rendered still more curious by the circumstance that in that position the beds are not tilted, or in any way apparently disturbed. They are arranged horizontally, as if the ocean floor on which they were deposited had occupied that level, or as if its deposits had been lifted up over so large an area that any small section of that area could retain its original horizontality. The lower Silurian gneiss beds on which these Secondary deposits have been laid are violently twisted and contorted, and this structure must have belonged to them when they constituted the floor of the Cretaceous sea; the position of the Miocene basalts capping the Secondary deposits proves that the whole mountain, as a mountain, is of later date than the Miocene age —how much later we cannot tell, and thus that the causes of geological change which have cut up the country into its present form, though they doubtless began in very remote epochs, have at least been prolonged into a comparatively late age in the history of the globe.

It would, I think, be affectation to pretend that our science enables us to follow with anything like distinctness of conception the exact nature and sequence of operations which through such a vast lapse of time have brought about the final result, but I believe in something like the following outline of events:—

First, that subsequent not only to the consolidation, but probably also to the metamorphism of the Lower Silurian deposits, the whole area of the Western and Central Highlands became an area of that kind of disturbance which arose from lateral pressure, due to secular cooling, and consequent contraction and subsidence of the crust of the earth. Second, that the crumpling, contortion, and tilting of the Silurian beds which we now see, arose from that disturbance. Thirdly, that then were determined those great general lines of strike running from south-east to north-west which are to this day a prominent feature in the physical geography of the country. Fourthly, that during that period of disturbance, and as part of the movement which then took place, the disturbed rocks fell inwards upon materials at a great heat, which rose in a pasty state along lines of least resistance, and thus came to occupy various positions sometimes intercalated among the sedimentary beds. Fifthly, that to this period, and to this method of protrusion, we owe some at least of the measures of granitic material which are abundant in the Highlands in particular; that to this period belongs the porphyritic granites on the north shores of Loch Fyne. Sixthly, that during the later ages of the Palæozoic period volcanic action broke out at various points, accompanied by great displacement and dislocation of strata, and that to this, with the denudation which followed, we owe much of the very peculiar scenery of the south-western coasts, especially in the district of Lorne, in Argyllshire. Seventh, that we have no proof that the Central Highlands were ever under the seas which laid down the deposits of the later Palæozoic age. Eighth, that such evidence as we have, points rather to the conclusion that they were not under such seas, since such fragments as remain of the Old Red and of the Carboniferous rocks appear to have been deposited round the bases and in the marginal hollows of the Silurian hills. Ninth, that, in like manner, we have no evidence that the great mass of the Central or Western Highlands were ever under the seas of the Secondary ages, which, on the contrary, appear to have deposited their sediment upon an area outside of, but probably surrounding, the area of these Central Highlands, and certainly upon those north-eastern and western flanks. Tenth, that the whole area of the Inner Hebrides and of the water dividing them, together with some portion of the mainland, as in Morven, was an area occupied by Secondary rocks. Eleventh, that in the Tertiary ages—probably in the Eocene and certainly in the Miocene—those rocks formed the bases of a great land of unknown extent, very probably extending for a great distance both to the east and west of the present coasts of Scotland and embracing the north of Ireland. Twelfth, that this country became in the Miocene age, and possibly earlier, the scene of great volcanic outbursts, which covered it with vast sheets of lava and broke up its Sedimentary rocks with every form of intrusive plutonic matter. Thirteenth, that later in the Tertiary periods and perhaps as late as the Pleiocene, this volcanic country was itself broken up by immense subsidences and upheavals, giving both occasion and direction to the agencies of denudation and to enormous removal of material. Fourteenth, that this Tertiary country had been thus broken up and nothing but its fragments left when the glacial epoch began, and that the main outlines of the country as we now see it had been already determined when glacial conditions were established. Fifteenth, that thus the work of the glacial period has been simply to degrade and denude pre-existing hills and to deepen pre-existing valleys. Sixteenth, that during the glacial epoch there was a subsidence of land to the depth of at least 2,000 feet above the level of the present sea, and again a re-elevation of the land to its present level. Seventeenth, that this re-elevation has not restored the land to the level it stood at before the subsidence began; but has stopped greatly short of it, and that the deep arms of the sea, or lochs, which intersect the country and some of the deeper fresh-water lakes, such as Loch Lomond, are the valleys still submerged which at the beginning of the glacial epoch were high above the sea and furrowed in flanks of loftier mountains; that during the glacial period the work of denudation and degradation was done, and done only, by ice in the three well-known forms—first, of true glaciers descending mountain slopes; second, of icebergs detached from the termination of these glaciers where they reached the sea; and third, by floe or surface ice driven by currents which were determined in direction by the changing contours of the land during the processes of submersion and re-elevation.

It would be impossible on this occasion to illustrate or support these various propositions by going into the evidences on which they rest; but as those of them which relate to the operations of the glacial epoch express a decided opinion upon questions now involving much dispute, I must say a few words in explanation or defence of that opinion.

It will be seen that I disbelieve altogether in this theory of what is called an ice-cap, or, in other words, I hold that there is no evidence that there ever existed any universal mantle of ice higher or deeper than all the existing mountains, covering them and moving over them from distant western regions.

In the first place, this theory presupposes conditions of climate which must have prevailed universally over the whole northern hemisphere, whereas over a great portion of that hemisphere, west of a certain meridian on the American continent, all traces of general glaciation and of any general distribution of erratics disappear. In the second place, the theory assumes that masses of ice lying upon the surface of the earth more than mountain deep, would have a proper motion of its own capable of overcoming the friction not only of rough level surfaces, but even of the steepest gradients, for which motion no adequate cause has been assigned and which has never been proved to be the natural consequence of any known force as to be consistent with the physical properties of the material on which it is supposed to have acted. In the third place, as a matter of fact, there does not now exist anywhere on the globe masses of ice which can be proved to have any motion of this kind or to be subject to forces capable of driving and propelling it in the manner and with the effects which the theory assumes. The case of Greenland, which is often referred to as an example, does not present phenomena at all similar to those attributed to

the ice-sheet. In the fourth place, all phenomena of glaciation which are exhibited on the mountain ranges, including the distribution of erratics, can be adequately accounted for by the three conditions or forms of moving ice which have been above enumerated, and all of which are now in actual operation on the globe—namely, ice moving, not up, but down mountain slopes by the force of gravitation, and ice floated by water and driven by currents, as icebergs or as floes. In the fifth place, these phenomena of glaciation are essentially different from those which would result from the motion of a universal ice-sheet, supposing it to have existed, and supposing it to have had the (impossible) motion which has been ascribed to it. In the sixth place, that, in particular, the mode in which erratics are distributed and the peculiar position of perched blocks are demonstrative of the action, not of solid, but of floating ice; whilst the surfaces of rock which have escaped glaciation on one side and retain the deepest marks of it upon another side, are equally demonstrative of exposure to moving ice, under conditions which did not enable it to fit into the inequalities of surface over which it passed. In the seventh place, the phenomena seem to me to prove that some of the very heaviest work done by ice has been towards the close of the glacial epoch, when the land was emerging again from out of a glacial sea, and when all the currents of that sea, loaded with bergs and floes, were determined entirely by the outlines of the rising land. In regard to the much disputed question of the glacial origin of lake-basins, the conclusion to which I have come is one which to some extent reconciles antagonistic views. I do not indeed believe that glaciers can ever dig holes deep under the average slope of the surface down which they move, but on the other hand they are the most powerful of all abrading agents in deepening their own bed and cutting away the rocky surfaces which lie beneath them. If valleys thus deepened by the long work of glaciers and glacier streams are afterwards submerged along with the whole country in which they lay, and if that submergence is accompanied by partial and unequal rates of subsidence, they would inevitably become hollows into which the sea would enter, or in which fresh waters would accumulate. In this sense and in this way it can hardly admit of a doubt that those lakes, which are nothing but submerged valleys, are due in part to glacial action, although the other half of the causation on which they depend is to be sought in the subterranean action of subsidence.

In conclusion, I would observe that although the fact of a great subsidence and a re-elevation of the land during the glacial epoch has been generally admitted to be one of the facts of which there is the clearest evidence, it is nevertheless a fact of which all the conditions and all the consequences have been most imperfectly recognised. Without venturing to go so far back as to imagine the process of subsidence and submergence, let us only think for a moment of that movement of re-elevation which has certainly been one of the very latest of the great movements of geological change. If it took place very gradually and very slowly, it necessitated the supposition that every inch of our mountain surfaces, up to at least 2,000 feet, has been in succession exposed to the conditions of a sea beach. Yet where are the marks upon them of such conditions? We may suppose such marks to have been generally obliterated by later sub-aerial denudation; but against this is to be set the fact that the position and distribution of perched blocks and other erratics deposited by floating ice demonstrates in my opinion that very little indeed of such denudation has taken place since they were placed where we now see them.

I could take any of you who are interested in this question to a precipitous hill near Inveraray, some 1,200 feet above the level of the sea, from the top of which you can look down on the masses of transported rock stranded upon its sides and base, precisely as one might look down from the top of some dangerous reef in the present ocean upon the *débris* of a whole navy of ships shattered upon it in some hurricane of yesterday. There they lie, some more or less scattered, some heaped upon and jammed against each other with sharp angles and outlines wholly unworn and, moreover, so distributed that you see at a glance their strict relation to the existing heights and hollows of the land, which must then have been the shoals and channels of the sea. These contours cannot have been materially changed since that sea was there. It seems that it must have been, geologically speaking, only a few days ago. And this conclusion would seem to be confirmed when we observe the phenomena which are presented in certain cases, where the land has clearly rested for a considerable time, and the ocean has left in raised beaches the evidence of its work at certain levels. Such raised beaches are to be found at many points all round our western coasts. But incomparably the finest and most instructive example of them is to be seen on the west coast of the Island of Jura, near the mouth of Loch Tarbert, Jura, and extending for several miles to the north. These beaches are visible from a great distance, because these rolled pebbles are composed entirely of hard white quartzite of the Jura mountains, which resists disintegration, and is unfavourable to the successful establishment of vegetation.

I visited these beaches a few weeks ago, and, measuring the elevation roughly with a graduated aneroid, I found that they represent three more or less distinct stages of subsidence. One beach being about the level of 50 feet above the present sea-level; another about 75 feet, and a third at about 125 feet. Some others which I saw only from a distance appeared to be higher, and I believe, but am not quite sure, that farther to the north they have been traced to the level of 160 feet. But the feature connected with these sea beaches, and especially with the lowest, or the 50 feet beach, is the evidence it affords—first, of the length of time during which the ocean stood at that level, and, secondly and particularly, the evidence it affords of the very recent date at which it must have stood there. As regards the length of time during which the ocean must have stood there, it is sufficient to observe the beautiful smoothness and roundness of the pebbles. They have been more thoroughly rolled and polished than the corresponding pebbles on the existing shores, equalling in this respect the famous pebble beds of the beach at Portland. Then, as regards the very recent date at which the ocean must have stood there, it is difficult to give in words an adequate idea of the impression which must be left on the mind of every one who looks at them. You see the curves left by the sweep of the surf, the summit level of its force, and the hollow behind that summit, which is due to the exhausted crest, all as perfect as if it had been the work of yesterday.

It is difficult to conceive how ordinary atmospheric agencies, and even the tread of sheep and cattle, should not have broken such an arrangement of loose material, but there are exceptionally favourable circumstances for the preservation of these beds from absence of considerable streams and the protection of surrounding rocks. There is little or no evidence of glaciation anywhere around, and, although it is certain that the sea which stood at those beaches so recently was a sea subject to glacial conditions, it is equally certain either that it continued to work there after those conditions had passed away, or, what is more probable, that that particular line of coast was protected from the drift of surrounding ice floes. If, now, we compare the evidence of recent action in these sea beaches with the similar evidence connected with the position of erratics at higher levels, which can only have been placed there by floating ice, I cannot help coming to the conclusion that the submergence and re-elevation of the land to the extent of more than 2,000 feet above the level of the present ocean has been one of the very latest changes in the history of this portion of the globe; and, moreover, that the re-elevation has been comparatively rapid, probably by lifts or hitches of considerable extent, and that there were few, if any, pauses or rests comparable in duration with those which are recorded in the Jura beaches and in the cutting of the existing coasts. In conclusion let me repeat that, whether this conclusion is correct or not—and I am well aware of the many difficulties which surround it—the general fact of submergence and re-elevation is, perhaps, as certain as any conclusion of geological science, and that the consequences of it in accounting for the distribution of gravels and the most recent changes of denudation have never as yet been worked out with anything approaching to consistency or completeness.

Professor GEIKIE, F.R.S., remarked that those who had watched recent discussion in physiographical geology might have been prepared, as he himself was, for a much greater divergence of opinion between the views expressed by the Duke of Argyll and those entertained by the younger school of geologists. While expressing his gratification at this approach, and at the very clear and eloquent views of the author of the paper, he ventured to point out some points where the arguments seemed faulty. He showed that the Highlands might have been covered with Old Red Sandstone, and that the antiquity of the present mountains could not be traced back to the primeval upheaval to which undoubtedly the general mass of Highland land was due. He pointed out that the absence of raised beaches could not be regarded as a disproof of the former presence of the sea, but indicated a period of pause during either a rapid or protracted upheaval.

Professor HARKNESS fully agreed in what Professor Geikie

had said in reference to the great value of the communication of his Grace. There were, however, some points to which he must take exception. He considered that the arrangement of the strata which form the metamorphic rock of the Highlands was not so difficult to unravel as some inferred. The southern portion of the series in many spots afforded clear section of the sequence and contortions, and he would specially refer to the section between Loch Tay and Glen Lyon. This section afforded clear evidence of mountains lying in a synclinal trough, a circumstance which could not be accounted for by contortions producing hills and valleys. He also agreed with Professor Geikie in considering that the Old Red Sandstone formerly covered a very large portion of the metamorphic rock, and he was more disposed to refer the outline of the Highlands to superficial denudations than elevations or subsidences of metamorphic strata. He referred to the importance of an investigation of the glaciation of the Outer Hebrides in any effort to solve the glaciation of the Highlands and Islands. He had for several years taken observations in these islands in regard to this subject, and the conclusions he had come to were that the whole of these outer islands had been glaciated from the Atlantic to the West; secondly, that during the period of submergence in the glacial epoch, icebergs and floes had dropped blocks on all our islands, many of which were finally perched; thirdly, he thought that local glaciers had also existed in Harris, at least, if not in South Uist. The glaciation of the Outer Islands was remarkably fine and should be visited by all interested in the glaciation of Scotland. Mr. Thomson had examined the conglomerates from the Mull of Kintyre to Loch Inver, in Ross-shire, and had never found a single section of the strata that contained similar pebbles and boulders to those found on the shores of Jura and Islay. He could not agree with Mr. Jolly in saying that the drifted boulders found in the Island of Lewis had all drifted from the West. Many were traceable to the mainland Cambrian age, and were found in Gare Loch and neighbourhood. In reference to the flexures of the valleys he quite agreed with his Grace, and referred to Tarbert, Loch Fyne, where there was one great flexure, rocks being contorted and broken up into every conceivable aspect; the great depth of water in Loch Fyne inducing the belief that the contour of the country was established previous to the deposition of the Mesozoic rocks.

The Rev. H. W. CROSSKEY remarked that the general glacial phenomena of Scotland could be explained without recurrence to the ice sheet. These phenomena were largely connected with local conditions The absence of any positive marks of sea-beaches was no proof against submergence. In many cases a small deposit accidentally discovered proved the submergence of miles of country. Some great salient facts in the order of events stood fairly established. In the first instance the land stood at a higher level. This was proved by remains of rivers beneath boulder clay, and other facts. Subsidence then occurred, and glacial shell clays were deposited. Owing to subsequent re-elevation a slight subsidence probably again took place previous to the final upheaval. As regards the last upheaval, he held that it took place gradually. Examination of the clays showed a quick passage from marine to estuarine conditions. He agreed with his Grace that the last upheaval was probably at a recent period, but it must be remembered that the highest beds of fossils of the series consisted of glacial forms. He asked attention to the great general order of the succession of beds.

Prof. W. C. WILLIAMSON, as a student of the Midland drifts, was surprised at the apparent agreement among the Scotch geologists in their non-recognition of Agassiz's ice-sheet. He was not able to acquiesce in their views on two grounds. The question turned upon the meaning of the terms glacietion and ice-sheet, which were terms representing relative magnitudes. The ice-covering of Greenland was practically an ice-sheet, and yet that it must have a coastward motion was shown by the icebergs which continually and through long ages broke away from it without reducing its area. In like manner the Antarctic ice along which the *Erebus* and *Terror* sailed for hundreds of miles without break, more than mast high above the water, and seven or eight times that amount below it, must have a similar motion. Again, the condition of the lower till, a true *moraine profonde*, devoid of all traces of marine life, could not be explained except on the supposition of a sub-glacial origin, a position in which all life was excluded, a condition intelligible on the supposition of formation under a broad ice-sheet.

Mr. Gwyn Jeffreys and Mr. Pengelly also took part in the discussion. The Duke of Argyll briefly replied, and thanks were accorded to his Grace for his interesting paper.

SECTION D.

BIOLOGY.'

Department of Zoology and Botany.

ADDRESS BY ALFRED NEWTON, F.R.S., F.L.S., V.P.Z.S., PROFESSOR OF ZOOLOGY AND COMPARATIVE ANATOMY IN THE UNIVERSITY OF CAMBRIDGE, VICE-PRESIDENT.

ANY one in the position of chairman of this Department must feel that his difficulty lies in choosing rather than in seeking a subject whereon to address an audience like that which is before me. This difficulty arises from the astounding abundance of interesting topics which are presented by the studies of botany and zoology--or of the latter alone, I may say, since it would ill become me to attempt the treatment of any which belong to the sister science. But it is of course incumbent upon me to touch upon the chief events of the past year which affect this Department; and it seems possible that in so doing we may find some considerations naturally proceeding from them to be worthy of your notice during the short time that I shall presume to occupy your attention, and also to present enough general interest to justify my enlarging upon the themes which they inspire.

These chief events appear to me to be two in number. It is my first and pleasing duty to congratulate the naturalists here assembled on the successful termination of that expedition in which we have all taken so great an interest, as, during its progress, tidings of it have reached us from one distant land after another, and especially (as your mouth-piece) heartily to welcome home all now present who were on board the good ship *Challenger* in her circumnavigation of the globe. I would that your spokesman on this occasion had been one who was better able to appreciate their labours and enter into details as to the value of their discoveries and researches. Unfortunately I am under the great disadvantage of being so imperfectly acquainted with the mysteries of the ocean, that it is only possible for me to speak in the most general terms of what has been done. I feel sure, however, that, so far as the great secrets of the sea can yet be interpreted and revealed by men, they will be by those who have happily returned to us, Sir Charles Wyville Thomson and his colleagues. There is one of their company we know they have not brought back; and it is fitting for us to lower the tone of our exultation while we remember the name of von Willemoes-Suhm. With this single sad exception there is, however, nothing, so far as I know, to occasion regret; and the various memoirs that have been already published by members of the expedition give a foretaste of what we may expect when the whole of its results are made known. I am informed that the rich collections made during the voyage are at present lodged in the University of Edinburgh, and are in process of revision and rough arrangement under the superintendence of the Director of the Scientific Staff of the late expedition. They include the products of dredging or trawling and surface-collecting at about 350 stations, and at depths varying from 100 to 4,500 fathoms, and consist of a prodigious number of specimens belonging to most of the groups of marine *Invertebrata*, especially of Sponges and Echinoderms, which preponderate at the greatest depths. It is, I believe, intended to obtain the assistance of special experts in working out the different groups; and I am sure this meeting will hear with pleasure that the *Hydrozoa* are to be intrusted to Prof. Allman, and the *Polyzoa* to Mr. Busk. It is understood that Her Majesty's Treasury will charge itself with the cost of publishing the treatises of these and the other eminent naturalists to be employed; and thus it is hoped that a series of volumes will be produced worthy of the magnitude of the subject, and fit for the first rank among the works of zoologists in this or any other country. I need scarcely add that the wishes of all here will be for the due carrying out of this grand scheme; and, remembering how often similar ambitious undertakings by our scientific men in combination with our Government have been baulked by untoward circumstances, we cannot but express the sincere hope that former failures will serve as useful warnings to ensure future success. I regret extremely my inability to say more on this subject.

I trust you will not think me to underrate the importance of the safe and prosperous return of the *Challenger* from her voyage, when, though naming it first, I ascribe to it the second place in the events of the past year as regards the progress of zoological investigation. Other scientific expeditions have before now left these shores and the shores of other countries, and have more or less fully attained their purpose while other expeditions will doubtless in due time be organised and carried out with, we

trust, like happy results. The voyage of the *Challenger*, though a highly important, and, in many respects, a novel one, is notwithstanding only a unit in a long series which began a century ago, and has been continued at intervals to our own day; nay, more, since the sailing of the *Challenger* we have witnessed the departure of another and larger expedition for the accomplishment of a still more arduous undertaking. But what I have now to speak of is a matter that will, if I am not mistaken, in after ages characterise the present year as an epoch in the history of our sciences inferior only in importance to that which marked some eighteen or nineteen years ago the promulgation of a reasonable Theory of Evolution by Mr. Darwin and Mr. Wallace. And while it is to the latter of these two naturalists that we owe the boon that has recently been conferred on us, it is unquestionably from the former labours of both—united yet distinct—that the boon acquires its greatest value. Without those far higher, far wider views which the Theory of Evolution enables us to take, the serried array of facts that bristle throughout the two volumes of the "Geographical Distribution of Animals"[1] which Mr. Wallace has just published, would have been but a comparatively meaningless aggregation of statements —the evidence no doubt of labour almost unsurpassed, the accumulation of much that is curious and of much that is suggestive, but, taken all in all, as serving to an unintelligible or insignificant end, if to any end whatever that was not misleading.

As the case is, the result is very different. But I would ask you now, Without the aid afforded by the "Doctrine of Descent," would it have been possible to draw, as Mr. Wallace has so skilfully drawn, those legitimate conclusions from a consideration of the animal life of Java (vol. i. pp. 352, 353), or to arrive at those marvellous results with respect to the past history of Borneo (vol. i. pp. 358, 359), or even to indulge in those daring speculations with regard to the origin of the Celebesian fauna (vol. i. pp. 436-438)? I cite these instances because they are taken from that part of the world on which the author's labours have before shed so much light, and with which his name is imperishably associated; but there is hardly any one of his summaries that does not place before us material for reflection as astounding.

While, however, assigning to the theory of evolution the chief glory in giving a real and lasting value to the interpretation of the facts of animal distribution, I must not omit acknowledging the share which physical geography has contributed to that end, especially by its marine surveys, which furnish the zoologist with data as to the depths of seas and oceans, and thereby enable him to judge as to the former extent of land. It is therefore to be expected that voyages like that of the *Challenger*, when their results have been fully worked out, will still further add to our knowledge in this respect. Again, too, geology (but this follows almost as a matter of course) has in its own line played an equal part. I would that botany could be mentioned in this connection, but here it seems as if the eldest of the biological sciences were not, as she usually is, in advance of the rest; and Mr. Wallace's suggestion (vol. ii. p. 162), that zoology furnishes a key wherewith many of the difficulties besetting the study of the distribution of plants may be unlocked, will doubtless meet with due attention from botanists.

Of the care and labour which the author of this work has bestowed upon it, no one here I venture to think, has a better right to speak than myself, because it is not very long ago that I attempted a dissertation on the geographical distribution of a single class of animals.[2] Though it was the class with which I am most familiar, and though in my attempt I had the invaluable assistance of Mr. Wallace's manuscript at my side, which cleared my way through many obstacles, still I found the task one of enormous difficulty, and one which I at times almost repented that I had undertaken; yet Mr. Wallace has treated not of birds only, as I did, but of mammals, amphibians, reptiles, and freshwater fishes—to say nothing of the most telling families of two orders of insects, with the molluscs so far as they were available for his purpose. There is nothing that in turning over the pages of these volumes so much strikes one as the energy they evince on the part of their author. Those who have been most accustomed to the literature of zoology must admit that there is scarcely any book with which "The Geographical Distribution of Animals" may not, in respect of hard and honest work, be advantageously compared. It deserves to bear good fruit; and I am greatly mistaken if it will not do so. From an educational point of view, it can hardly fail to be of the greatest service. Attractive as is the subject to those that know it and see its bearings, the learner has hitherto been repelled from its consideration by the want of any work of general compass which would guide his studies, while even few of those treatises which have a particular scope were of much use to him. Mr. Wallace has now placed one in his hands; and the result we need not try to anticipate. One thing, however, is clear—the distribution of animals can no longer be neglected as a secondary or unimportant part of zoology. It only remains for me to add, while thus attempting to set forth the general merits of this learned work, that I by no means pin my faith to all the author's details, or to all his conclusions. Most of the latter may indeed be justified by the present imperfect state of our knowledge; but it does not follow that they will eventually meet with common acceptance. I must particularly call your attention to the admirably cautious words in which he takes leave of his readers —words that prove him to be thoroughly imbued with the right spirit of a true worker in a progressive branch of study. Mr. Wallace says:—

"The preceding remarks are all I now venture to offer on the distinguishing features of the various groups of land-animals as regards their distribution and migrations. They are at best but indications of the various lines of research opened up to us by the study of animals from the geographical point of view, and by looking upon their range in space and time as an important portion of the earth's history. . . . Till every well-marked district—every archipelago, and every important island, has all its known species of the more important groups of animals catalogued on a uniform plan, and with a uniform nomenclature, a thoroughly satisfactory account of the geographical distribution of animals will not be possible."

And then he goes on to point out that more than this is wanted:—

"Many of the most curious relations between animal forms and their habitats, are entirely unnoticed, owing to the productions of the same locality *never* being associated in our museums and collections. A few such relations have been brought to light by modern scientific travellers; but many more remain to be discovered, and there is probably no fresher or more productive field still unexplored in natural history."

These coincident variations, he concludes by saying, "have never been systematically investigated. They constitute an unworked mine of wealth for the enterprising explorer; and they may not improbably lead to the discovery of some of the hidden laws (supplementary to natural selection) which seem to be required in order to account for many of the external characteristics of animals" (vol. ii. pp. 552, 553).

And now to follow out the idea with which I began. Having touched on the two chief zoological events of the year, let us see if they do not suggest something that will not be beneath your consideration for the remainder of this address. I have spoken of the certainty of the expedition from which we now welcome our friends being succeeded by others of similar character. We shall hardly be indulging any vain imagination if we ask ourselves what we may look forward to as regards their reports; and to one point we may perhaps usefully apply ourselves.

What if a future *Challenger* shall report of some island, now known to possess a rich and varied animal population, that its present fauna has disappeared? that its only mammals were feral pigs, goats, rats, and rabbits—with an infusion of ferrets, introduced by a zealous "acclimatizer" to check the superabundance of the rodents last-named, but contenting themselves with the colonists' chickens? that sparrows and starlings, brought from Europe, were its only land-birds, that the former had propagated to such an extent that the cultivation of cereals had ceased to pay—the prohibition of bird-keeping boys by the local school-board contributing to the same effect—and that the latter (the starlings) having put an end to the indigenous insectivorous birds by consuming their food, had turned their attention to the settlers' orchards, so that a crop of fruit was only to be looked for about once in five years—when the great periodical cyclones had reduced the number of the depredators? that the goats had destroyed one half of the original flora, and the rabbits the rest? that the pigs devastated the potato-gardens, and yam-grounds? This is no fanciful picture. I pretend not to the gift of prophecy; that is a faculty alien to the scientific mind; but, if we may reason from the known to the unknown, from what has been and from what is to what will be, I cannot entertain a doubt that

[1] "The Geographical Distribution of Animals, with a Study of the Relations of Living and Extinct Faunas as Elucidating the Past Changes of the Earth's Surface." By Alfred Russel Wallace, Author of "The Malay Archipelago," &c. 8vo, two vols. London, 1876.

[2] Geographical Distribution of Birds in "Encyclopædia Britannica," Ed. 9, vol. iii., pp. 736-764.

these things are coming to pass; for I am sure there are places where what is very like them has already happened.

You may ask why this is so? why do these lands so speedily succumb to the strangers from beyond sea? One part of the answer is ready to hand with those who have learned one of the first principles of biology which our great master, Mr. Darwin, has laid down for us. The weaker, the more generalised forms of life must always make way for the stronger and more specialised. The other part of the answer is supplied by Mr. Wallace; for no one can have studied his volumes to much purpose without perceiving that the inhabitants of oceanic islands and of the southern hemisphere—the great Australian Region especially, and South America not much less, are the direct and comparatively speaking little-changed descendants of an older, a more generalised and a weaker fauna than are the present inhabitants of this quarter of the globe, which have been, so to speak, elaborated by nature and turned out as the latest and most perfect samples of her handiwork.

Set face to face with unlooked-for invaders, and forced into a contest with them from which there is no retreat, it is not in the least surprising that the natives should succumb. They have hitherto only had to struggle for existence with creatures of a like organisation; and the issue of the conflict which has been going on for ages is that, adapted to the conditions under which they find themselves, they maintain their footing on grounds of equality among one another, and so for centuries they may have "kept the noiseless tenor of their way." Suddenly man interferes and lets loose upon them an entirely new race of animals, which act and react in a thousand different fashions on their circumstances. It is not necessary that the new comers should be predacious; they may be so far void of offence as to abstain from assaulting the aboriginal population; but they occupy the same haunts and consume the same food. The fruits, the herbage, and other supplies that sufficed to support the ancient fauna now have to furnish forage for the invaders as well. Their effects on the flora there is no need for me to trace, since Dr. Hooker expressly made them one of the themes of that discourse to which many of us listened with rapt attention a few years since at this Association. But the consequences of the invasion to the native fauna have never been so fully made known. The new comers are creatures whose organisation has been prepared by and for combat throughout generations innumerable. Their ancestors have been elevated in the scale of being by the discipline of strife. Their descendants inherit the developed qualities that enabled those ancestors to win a hard-fought existence when the animals around them were no higher in grade than those among which the descendants are now thrown. Can we doubt that the victory inclines to the heirs of the ancient conquerors? The struggle is like one between an army of veterans and a population unused to warfare. It is that of Spaniards with matchlocks and coats of mail against Aztecs with feather cloaks and bows and arrows. *Mala salus victis.* A few years, and the majority of native species are exterminated. But this is not the worst. The species which perish most quickly are just those that naturalists would most wish to preserve; for they are those peculiar and endemic forms that in structure and constitution represent the ancient state of things upon the earth, and supply us with some of the most instructive evidence as to the order of nature.

With the progress of civilisation it is plain that there will soon be hardly a land but will bear the standard of a European nation or of a community of European descent, and, as things are going on, be overrun by their imports. If this were inevitable, it would be useless to complain. But is it inevitable? Is it not obvious that most of this extermination is being carried on unwittingly, and may not some of it be avoided by proper precautions? If so, should not men of science make a stand, and interest the ignorant or careless in the importance of the subject? I cannot divest myself of the belief that the course of the next century will see the extirpation, not only of most of the peculiar faunas I had in view a few minutes ago, but of a great multitude of other species of animals throughout all parts of the world. The regret with which I regard such extirpation is not merely a matter of sentiment. Here sentiment and science are for once on the same side. A heavy blow will be inflicted on zoology by the disappearance of some of these marvellous and peculiar forms. There is no one species of animal whose structure and habits have been so completely investigated that absence of the means of further examination would not be a distinct deprivation to science; and as what Science has done is only an earnest of what she will do, we cannot say that the time shall ever come when the want of those means will not be severely felt. It is then for scientific men, and for naturalists especially, to consider whether they are not bound, in the interest of their successors, to interpose more than they have hitherto given any sign of doing.

But outside this audience there are many who care little for consequences like these. Such persons may, however, be impressed by thinking that the indiscriminate destruction of animals which, in one way or another, is now going on, must sooner or later lead to the extirpation of many of those which minister to our wants, whether of comfort or luxury. The fur-bearing creatures will speedily, if they do not already, require some protection to be generally accorded to them; and that such protection can be effectually given is evident if we take the trouble of inquiring as to the steps taken by the Russian local authorities in Alaska, and now, I believe, continued by those of the United States, for limiting the slaughter of the sea-otter and the fur-seals of the adjacent islands to particular seasons. No one can suppose that, even with the assistance we get from Siberia, our supply of ivory will continue what it now is when the interior of Africa is pacified and settled, as we can hardly doubt that it one day will be; and, unless we can find some substitute for that useful substance before that day comes, it would be only prudent to do something to check the wasteful destruction of elephants. Many people may think that the continent of Africa is too vast, and its animal life too luxuriant, for the efforts of man materially to affect it. If we inquire, however, we shall find that this is not the case, and that there is an enormous tract of country, extending far beyond our colonies and the territories of the neighbouring republics, from which most of the larger mammals have already disappeared. There is good reason to believe that at least one species has become extinct within the last five-and-twenty years or thereabouts; and though I do not mean to say that this species, the true zebra, had any economic value, yet its fate is an indication of what will befall its fellows; while to the zoologist its extirpation is a matter of moment, being probably the first case of the total extinction of a large terrestrial mammal since the remote days when the *Megaceros hibernicus* disappeared.

Time would fail me if I attempted to go into particulars with regard to the marine *Mammalia*. It is notorious that various members of the orders *Sirenia*, *Cetacea*, and *Pinnipedia*, have recently dwindled in numbers or altogether vanished from the earth. The manatee and dugong have been recklessly killed off from hundreds of localities where but a century or so since they abounded; and with them the stores of valuable oil that they furnished have been lost. That very remarkable Sirenian, the huge *Rhytina gigas* has become utterly extinct. The greed of whalers is believed to have had the same effect on a Cetacean (the *Balæna biscayensis*) which was once the cause of a flourishing industry on the coasts of France and Spain. The same greed has almost exterminated the right-whale of the northern seas, and is fast accomplishing the same end in the case of seals all over the world. You are probably aware that an Act of Parliament, passed in the session of 1875, was intended to put some check upon those bloody massacres that annually take place on the floating ice of the North Atlantic, to which these creatures resort at the time of bringing forth their young, when

"Sires, mothers, children in one carnage lie"

But, whether through official indifference, or what, I know not, the treaties with foreign nations authorised by that Act were not completed; and last spring, at the solicitation of certain Aberdeen or Peterhead shipowners, the Board of Trade allowed "one year more" of wholesale slaughter. Whatever other nations might like to do, our hands at least should have been unstained. It is admitted that in certain manufactures—that of jute, for instance—animal oil is absolutely necessary. It is easy to see that before long there will be very little animal oil forth-coming.

There is another class of animals with whose well-being the interests of man are largely connected. It cannot be denied that our fisheries are year by year subjected to an ever-increasing strain, through the rapidly increasing population of these islands, and are giving unmistakable signs of being unable to bear it. But it must be admitted that the consideration of their case is fraught with unusual difficulties. Commissions, either Royal or Parliamentary, have been appointed one after another to inquire into the facts and to seek a remedy, if one is to be found, for the falling off. It is with great diffidence that I venture to pass any criticism on the recommendations made by those Commis-

sions, and especially on such as were contained in the Report of a Commission the constitution of which was such as to inspire the greatest respect, since men so eminent as Prof. Huxley and Mr. Holdsworth were named in it. That Commission reported in effect that there was nothing to be done with our sea-fisheries but to leave things alone. I do not profess to quote the words of the Report (which, indeed, I have not seen for a long time); but in substance, I believe, it amounted to this:—That the natural enemies to which fishes were exposed were so multitudinous, so crafty, and so rapacious, that their destruction by man was very slight in comparison, and that his interference might be safely neglected in considering its consequences. Now it has always seemed to me that the Commissioners on this occasion suffered themselves to be deceived. Well aware of how little is known as to the indirect effects of man's acts in regard to the lower animals, and in their fear lest any unforeseen bad results should follow from measures intended to be remedial, they recommended none at all. But I fail to discern that land or sea makes any essential difference in the laws of life. The balance of nature must be preserved as steadily in a dense as in a rare fluid—in water as in air—or all will not go well. Whatever be the weight in either scale, equipoise is as easily destroyed by an ounce as by a ton. The marine fishes that are of such commercial importance (cod, herrings, and the like) have naturally, no doubt, enemies innumerable—dogfish, cormorants, porpoises, and what not; but we know that, owing to their fertility and habits, the cod and herrings have continued till lately to contend successfully with these drawbacks and to maintain their numbers. It matters not if only one egg of the 10,000, or whatever be the number in the roe of a herring, produces a fish that arrives at maturity and escapes its natural enemies, so long as that one fish is sufficient to supply the place of its parent. Now this, according to the arrangement of nature, has hitherto been the case. But if, instead of that fish living to propagate its kind, it is cut off before its time by an enemy against whom nature has made no provision, her balance is at once destroyed; and the oftener the operation is repeated the sooner will the numbers of the species dwindle; and the dwindling will go on in a rapidly accelerated ratio. Therefore it seems that, so far from leaving our sea-fisheries unrestricted, it is highly necessary to impose some limitation upon them; and, so far from dreading interference, our interference is at present so fatal that further interference of another kind is required as a counterbalance; while that counterbalance science only can apply.

As much may be said for those other industries, in common speech also called "fisheries"—the taking of oysters, crabs, and lobsters, all of which have lately been diminishing in a still more alarming degree. Here Parliament has wisely resolved to interpose, though whether the manner of interposition is wise seems to be a matter on which, as few naturalists have been consulted, we had better reserve our opinion.

Thus, without troubling you with many technical details, I have striven to lay before you a sketch of man's treatment of some of his fellow creatures, and of the effects which have sprung, or certainly will spring, from it. There is probably hardly an island on which he has set foot the fauna and flora of which has not been in some degree influenced by his even temporary presence; there is assuredly not a continent, though a continent takes longer to subdue: and his control does not stop at the shore; for, if what I have been advancing is true, the inhabitants of the deep come also more or less under his dominion. I invite you to contemplate whether it is always, or even generally, that of a beneficent ruler. But it will, doubtless, be urged that this kind of thing has gone on for ages—ever since life first existed on the earth. I may be told, in the words of the great poet of the country in which we now find ourselves—

> "Look abroad through Nature's range,
> Nature's mighty law is change;
> * * * * * * *
> Why then ask of silly man,
> To oppose great Nature's plan?"

I would answer from the same source that

> "—man, to whom alone is giv'n
> A ray direct from pitying Heav'n,"

should by means of that ray not oppose nature, but rather second her preservative measures. That ray is the ray of science. We can only govern nature by obeying her, only by obeying her can we assist her. To obey her laws we must know them; what can we know of them but what science teaches us?

It may be said that I have taken too gloomy a view of this matter of the extirpation of animals by man. I wish I could think so. But I believe that if we go to work in the right way there is yet time to save many an otherwise expiring species. In this country there is happily a strong disposition, which grows stronger day by day, to preserve our wild animals. It is very desirable that this feeling should not be limited to the British Islands. If it is, as I maintain, a right feeling—a feeling sanctioned alike by humanity, by science, and by our own material interests—it cannot be too widely disseminated. But its propagation must not be left to humanitarians and sentimentalists, whose efforts are sure to be brought to nothing through ignorance and excess of zeal, nor to economists, whose endeavours would unquestionably fall short of what is required. The officiousness of the one class and the slackness of the other must equally be tempered by the naturalist. He can be trusted not to interfere with the use, but with the abuse, of the animal world. Only to do this he must place himself in the forefront of the movement; for he can submit to no other leader. He alone has, or should have, that knowledge which gives the power of coping successfully with the difficult questions that will arise; and the advantage it gives him he must not abstain from exercising. If, without offence, I might here paraphrase some venerable words, I would say that, according to the greatness of this power, we must preserve those that are otherwise appointed to die.

THE NORWEGIAN ATLANTIC EXPEDITION[1]

IN continuation of my last notice, I may say that the Expedition stayed at Reikiavik from July 26 to Aug. 3. While Capt. Wille made magnetical observations on shore, the majority of the members of the expedition made a tour to Thingvalla, where they had the pleasure of falling in with an Englishman coming from the north and bound for the Geysers; we had a very happy evening together. The remarkable geological structure of the country attracted much interest. The excursion party returned July 30. Stormy weather prevailed during the whole stay at Reikiavik, so that the coaling was much delayed, and no magnetical observations could be made on shore. A small leak in the boiler took up most of the last day to set it right, and at last we got away on the evening of the 3rd. The season was now so far gone that we were obliged to give up the idea of exploring the sea between Iceland and Greenland, and we shaped our course south of Iceland again, and then towards N.E., running out a line of soundings which showed the transition from the warmer Atlantic water at the bottom, to the ice-cold Arctic water east of Iceland. During a dredging on the bank, between Iceland and Faroe, on a hard, probably volcanic, bottom, the line got fast on a rock, and it became necessary to break it; we thus lost a dredge and some hundred fathoms of dredging line. From a point east of Iceland, the course was laid for Namsos, and several deep sea stations were well explored on this line. The depth at first increased from 1,000 fathoms to 1,500, and at last to 1,800, the last being midway between Norway and Iceland in lat. 64° 65'. The more easterly soundings gave a less depth, the last of them being only 650 fathoms. The temperature at the bottom was always under 32°; at 1,800 fathoms it was 29°, corrected for the error of the thermometer, and for that caused by pressure. The layer with 32° was found in about 200 fathoms east of Iceland, and in 300 or 400 fathoms further east. It seems that the Faroe bank prevents the warm Atlantic water from filling up the upper layers of the northern seas to such a depth on the north-east side of these islands, as it does in the interval between this region and the cold sea east of Iceland. The nearer Norway the warmer is the upper layer of the sea, not only on the surface, but at the depths of 100 and 200 fathoms.

The fauna of the Arctic deep sea seems to be very constant, while it is not very rich; the same specimens have been found farther south in ice-cold water, but none of the large forms found in ice-cold water near the coasts (were met with by us[2]). The bottom consists of mud, with innumerable specks of small round calcareous shells.

During the last cruise, the weather was constantly bad; nevertheless, it has been possible to work the deep-sea apparatus even in gales, and with a sea in which the ship went bowsprit under. This result has been attained after successive experiments. The last working day the dredge and trawl were sent out together, the latter *behind* the former. The weather was stormy, the sea very high, but the experiment was made, and the dredge came well on board. After this result, we can now see no objection to working all the deep-sea apparatus in any kind of summer

[1] Continued from p. 338.
[2] Probable omission in original.

weather when the depth does not exceed 600 or 700 fathoms. Unhappily, in bad weather, the zoologists cannot study the specimens found in a living state, the motion of the ship killing the animals very soon. The Expedition arrived at Namsos August 14, the scientific staff and the crew being much exhausted by the perpetual bad weather. At Namsos we stayed till the 20th to rest. Meanwhile magnetical observations were made on shore. On board, the bad weather entirely prohibited our making any.

After leaving Namsos, series of soundings every four miles (nautical) were taken from the Folden-fjord, and due west. First we found a hollow 200 fathoms deep, with a constant temperature of 7° C., then a slightly inclined ridge, whose highest point shoaled up to 56 fathoms, then came an incline down to 120 to 150 fathoms, and after that a flat bottom at the last-named depth. Over this flat the temperature was constantly 7° C. At last, about 11 o'clock on Monday the 21st, the depth increased, the temperature decreased, and we found ice-cold water in somewhat more than 300 fathoms depth. This was 100 nautical miles off the nearest coast and not very far from our last deep-sea station, where the depth was 580 fathoms, temperature $-1^{\circ}\cdot 3$. Such an extent of the Norwegian banks at this place was not expected, but is very interesting. It now seems probable that the boundary line of the ice-cold water runs from a point 100 miles off the coast at Namsos up to Spitzbergen, outside the Lofoden Islands, and this breadth of the bank explains the mild winter climate which Northern Norway enjoys. As a series of soundings and temperatures showed the next day in a line direct from west to east in the latitude of the mouth of the Trondhjem-fjord, the boundary of the bank and of the ice-cold water goes here and off Romsdal much nearer to the coast. The water was at 0° C. in 345 fathoms, and at the bottom $-1^{\circ}\cdot 1$ C. in 480 fathoms depth. On the bank inside there was a temperature of $7^{\circ}\cdot 3$ on the bottom at 170 fathoms depth. On the morning of the 23rd the *Vøringen* was outside the coast of Romsdal, and in foggy weather got very near the dangerous coast. Happily the fog lifted and a pilot came on board, who took the ship into Molde. The next day the expedition was sounding, trawling—with no result—and taking serial temperatures in the Romsdal-fjord. The result was the same temperature in the depth of the fjord as in the other deep fjords on the west coast of Norway, viz., $6^{\circ}\cdot 2$. In the evening the expedition arrived at Aalesund, where the ship in a very strong gale was nearly driven ashore in the harbour. Happily the wind abated and the chains held, so that the voyage could be continued the next morning.

On Saturday, August 26, the expedition returned to Bergen, where the ship will be paid off. The members of the expedition are all very well and look with much interest to the time when they can commence to discuss their observations which, in spite of the bad weather generally experienced this summer during the cruise, are numerous and interesting.

NOTES

THE Prussian Government has sent the following gentlemen to examine thoroughly the special Loan Collection of Scientific Apparatus, and to report on the objects exhibited:—From the Ministry of Commerce—Professors-Doctors Landolt, Aix-la-Chapelle; Krant, Hanover; Liebermann, Berlin; Wullner, Aix-la-Chapelle; von Quintus-Icilius, Hanover; Gerland, Cassel; Paalzow, Berlin; Helmert, Aix-la-Chapelle; Stahl, Aix-la-Chapelle; Dorgens, Berlin. From the Ministry of Education—Professors-Doctors Cronecker, Leipzig; Abbe, Jena; Hensen, Kiel; Karsten, Kiel; Herr Appuun, Hanau; Professors Doctors Kundt, Strasburg; Listing, Gottingen; Cohn, Breslau; Lassaulx, Breslau; Bruns, Berlin; Lowenhorz, Berlin. From the Ministry of Agriculture—Dr. Scheibler, Berlin.

THE annual meeting of the Ray Society was held in Glasgow on Friday under the presidency of Prof. Young. The secretary, Rev. T. Wiltshire, submitted the report of the council, in which they congratulate the members upon the progress of the Society. With regard to the issue of the volumes, some unexpected delays, chiefly due to the lengthened period requisite for the careful colouring of the plates, have hindered the appearance of the work for the year 1875. As, however, all the plates are at the present moment coloured, and most of the text in type, it is certain that the book will be published within a brief period. Originally it was proposed that the volume for 1875 should comprise a description by Mr. G. B. Buckton of the whole of the British Aphides. The plan suggested at the commencement has, from the exigencies of the case, been somewhat defeated; the researches of Mr. Buckton have brought to light so many new species that it seems probable that the Monograph will require at least two, if not three, volumes of text and plates. The first of these, containing forty coloured plates and the necessary introduction, will form the publication for the year 1875. The succeeding parts are now being proceeded with, and will be ready as soon as an opportunity offers for their issue. Since last annual meeting Prof. Huxley had offered to prepare an introduction to the MS. of the Tunicata left by the late Mr. Hancock, and Mr. Cameron had proposed a monograph on the British Tenthredinidæ. These have been accepted, and will be commenced with all possible speed. On account of the changing location of the British Association, the Council propose that for the future the annual meetings be held in London within three months of Lady-day. It was recommended that the following names be added to the Council:—Prof. Bentley, Sir A. Brady, Dr. Gwyn Jeffreys, and Mr. Hudson. The statement of accounts showed that there was a balance in favour of the Society of £156 18*s.* 11*d.* On the motion of Prof. Balfour, the report was adopted. Votes of thanks were subsequently passed to the retiring members of Council and to Prof. Young for presiding, and the meeting separated.

A GENERAL meeting of the Mineralogical Society of Great Britain and Ireland was held in the Natural History Class Room of the Glasgow University on Wednesday, Sept. 6. The chair was taken by Prof. M. Forster Heddle, M.D., in the absence of the president, Mr. H. C. Sorby, and there was a large attendance. The chairman delivered an address on "Scotch Minerals, how and where to find them." This was followed by the reading of a paper by the president "On the Critical Point in the Consolidation of Granite." Prof. Haughton, of Trinity College, Dublin, then followed with an address on a new principle in the consolidation of porphyritic rocks, which he proposed to call "the principle of least paste." Some discussion of this principle and of Mr. Sorby's paper then took place, in which Prof. Harkness and Dr. Bryce joined. The following papers were afterwards read:—"On a Mineral from New South Wales, presumed to be Laumontite," by Prof. A. Liversidge; "Notes on an Old Catalogue of Minerals," by Prof. A. [illegible] Church; "On the Occurrence of Achroite at Rock Hill, in the Parish of St. Austell, Cornwall, and on the Black Tourmaline of the same Locality," by J. H. Collins.

THE Oriental Congress, which met at St. Petersburg during the first ten days of the present month has been doing much good work in its own department. Many papers have been read, most of them connected with Russian, or at least Asiatic Russian, ethnology and archæology. The members of the Congress have been heartily welcomed and well treated at the Russian capital, and among those who have enrolled themselves members is the ubiquitous Emperor of Brazil. Among the papers read was an important one on the "Caucasian Race," by Prof. Gregorief, in which he pointed out the accidental origin and the unsuitability of the term, and endeavoured to trace the origin and migrations of the race indicated. He showed that even at the present day many Aryans are to be found in Central Asia. Mr. Berger made a communication on many of the ethnographical objects belonging to the Caucasian Department of the Congress's Exhibition. Another paper on the Aryan Race was by the Rev. Mr. Long, of Calcutta, and Prof. Oppert remarked on the Asiatic tongues

families, but which are found in the Arrow-headed texts. These incapable of being referred to either the Aryan or Semitic languages he styled Susi-Medic, which, he said, were spoken in Iran and Khusistan centuries before the Persians bore rule in these countries. A series of questions was discussed relative to Central Asia, proposed by the Organising Committee in a general list of problems issued before the opening of the Congress. One of these was, "Was there a Mongol Tribe or People before Genghis Khan? or is the name Mongol nothing more than a dynastic one adopted by Genghis to denote the Empire which he founded?" The loose use of the term "Turanian" was much criticised. The Russian Government has given the Congress a hearty welcome.

On Tuesday the Geographical Congress, convened by the King of the Belgians, met in the Palace, at Brussels, under the presidency of his Majesty. The King said that in calling the Congress he had no ambitious aims in view, but that his sole object was to accelerate the introduction of civilisation into Africa. He afterwards dwelt upon the necessity of establishing hospices and scientific stations on the confines of the unexplored territories there, and the formation of an international committee to carry out the work. Nachtigall, Schweinfurth, Rohlfs, Grant, and Cameron gave a brief *résumé* of their travels; Negri also spoke. The Congress, on the King's proposition, then divided into sections by nations. The English met at four with the French, and recommended a station from which the Lakes could be reached. Admiral de la Roncière le Noury and M. Mounoir are present as representatives of France, and Sir Bartle Frere, Sir John Kennaway, Commander Cameron, Sir Henry Rawlinson, Sir Rutherford Alcock, Sir Harry Verney, and others represent Great Britain. The convening of this Congress is highly creditable to King Leopold, and may be regarded as significant of his zeal for science and the spread of civilisation. This kind of work, like mercy, of which, indeed, in the highest and truest sense, it is but an outcome, "becomes the throned monarch better than his crown."

We notice with pleasure the appearance of the first number of the *Bulletin* of the newly-founded Zoological Society of France, which came into existence this summer. The present number of the *Bulletin* contains six papers, the first being by the president of the Society, M. Jules Vian, treating of the *Phaleris psittacula* in Sweden, and of the occurrence in France of the small Puffin (*Mormon grabæ* of Brehm), to which the author is inclined to grant specific rank. Of the *Phaleris* a description and figure of the skeleton is given. The second paper is by M. E. Simon, and describes two new species of spiders from the Congo. The third contribution is by Dr. Jousseaume, on the "Faune Malacologique des Environs de Paris." Mr. Bowdler Sharpe, of the British Museum, in conjunction with M. A. Bouvier, next describes a collection of birds sent from the Congo district by M. Petit. A new swallow, *Psalidoprocne Petiti*, is figured (Pl. II.), but perhaps the less said about this plate the better, as the artist, M. Bevalet, appears unable to distinguish between the characteristic habit of a swallow and a humming-bird, to the drawing of which latter group he has been for some time devoted in connection with M. Mulsant's work on the *Trochilidæ*. M. L. Bureau communicates an abstract of his essay on the Booted Eagle (*Aquila pennata*), which he had lately read before the French Association for the Advancement of Science at Nantes; and lastly, Prof. Perrier gives an account of the star-fishes collected in the Cape Verd Islands by M. Bouvier. We wish every success to the Society, whose address is at present No. 55, Quai des Grands Augustins, Paris.

The death is announced, at the age of eighty-one years, of the German naturalist, Christian Ehrenberg, *doyen* of the Professors of the University of Berlin. He was born in 1795. By the age of thirty-two he had published numerous works, and was made professor extraordinary of the University. In 1829 Humboldt chose Ehrenberg to accompany him in his expedition to Siberia. He was made titular professor in 1839. Ehrenberg has done much to popularise the use of the microscope. His great treatise on the Infusoria, for which he collected the materials during his journey with Humboldt and Gustav Rose, is well known to naturalists.

Prof. Huxley, we learn from *Harper's Weekly* of the 9th inst., made an auspicious start on his tour through the United States. After a notable dinner given to him at New Haven, by Prof. Marsh, he departed with Governor Ingersoll, Prof. Marsh, President Bishop of the New Haven Railroad, and a few friends, in a palace-car for a trip through Canada and westward to the Mississippi. On his return, after visits to Prof. Agassiz and Prof. Gray, of Harvard, he was on Tuesday to deliver an address at the opening of the Johns Hopkins University at Baltimore, and then betake himself to England again. "All this, of course, on the basis that American citizens do not in the mean time kill the British *savant* with the beef, the birds, and the multitudinous bibbles for which America is famous."

We are glad to see that the Yorkshire College of Science is so far advanced and established as to publish a Calendar, a copy of which has been sent us. It contains ample information as to the classes, resources, aims, and work of the College, and, to judge from the programmes of the various classes, a great amount of valuable instruction must be given during the session. We hope to see the Calendar enlarged each year, and the number of professors and classes increased, until the College becomes a great centre of liberal culture for Yorkshire. Any one wishing to learn what is the present position of the College should get this Calendar and the Prospectus of day and evening classes for 1876 77.

The arrangements for the South African International Exhibition, to be opened at Cape Town in February next, are making satisfactory progress. Everything intended for exhibition must be shipped from London not later than the first week of December. The European Commissioner is Mr. Edmund Johnson, 3, Castle Street, Holborn.

We have received a catalogue of the Industrial Exhibition which is being held at Helsingfors. It contains 3,290 entries in the various departments of industry represented; so far as we can judge from the catalogue, the exhibition is highly creditable to the Finlanders.

The programme for the next French International Exhibition, 1878, has been published in the *Journal Officiel*. The regulations are substantially the same as in former exhibitions. The building is to be a long parallelogram, and will be divided into rectangular stripes, two of these stripes being allotted to special divisions, one for France, and the other for foreign countries. Fine arts will enjoy the central stripe, and consequently be an exception. Right and left will be placed the two stripes allotted to scientific industries, under the name "Education, Teaching, Methods and *Materiel* of Liberal Arts." Amongst the principal attractions of the Exhibition will rank a gigantic Giffard steam captive balloon. It will measure 21,000 cubic metres, and exceed by 10,000 the former captive balloon at Ashburnham Park. The rope will weigh 20 pounds per yard, and the elevation will be 500 yards. The steam-engine will have 200 horse-power; thirty persons will ascend at once, and in calm weather, 100. The new captive balloon will require no circus for protection, and will stand in the midst of a large square fronting the bridge in the central alley of the gardens. Meteorological observations with special instruments will be made during the ascents for the instruction of excursionists, and recorded for the benefit of science.

MR. WYLD, of the Strand, has published a map which will be found very useful by those who desire to understand, in all its bearings, the significance of the present unhappy war which is being waged in the Turkish dominions. The object of the map is to show the distribution of the various peoples which inhabit the Turkish provinces and dependencies, this object being effected by the use of various shades of colour for the various families of people—Sclaves, Walachians, Albanians, Turks, &c. It shows in what a comparatively small minority are the real Turks, and how important is the Sclavic element, though the Mahommedans are spread more or less over all the provinces; still they are in a decided minority. The variety of colouring used is at first rather puzzling, as it is difficult to make the shades sharply distinct, but after a little careful examination a very satisfactory general idea will be obtained of the ethnology of the Turkish dominions.

DR. MICHAEL FOSTER is preparing a Text-book of Physiology for the use of Medical Students and others; it will be published in November by Messrs. Macmillan and Co.

MESSRS. MACMILLAN AND CO. have published as a shilling pamphlet Dr. Richardson's address, "Hygeia, a City of Health," which he delivered last October at the Meeting of the Social Science Association at Brighton.

MR. W. F. HUSBAND has been selected as secretary and registrar to the Yorkshire College of Science, and secretary to the Leeds Philosophical and Literary Society. Mr. L. C. Miall retains the office of curator of the society's museum, also holding the professorship of biology at the college.

The *Times* Paris correspondent states that in digging the new basin at St. Nazaire, animal remains, tools, weapons, and utensils have been found in a sandy stratum six metres from the surface. Last year a dolichocephalous skull was found near the same spot, which Dr. Broca declared to belong to the age of stone.

THE Council of the Paris Observatory has resolved to attempt the manufacture of object-glasses by machinery, instead of by hand. The mechanical cutting of flint and crown glass will be executed by M. Lessautre, the well-known clock-maker, who prepares the optical part of French lighthouses by machinery.

WE regret to see that the Italian African Expedition has been so badly treated in its progress southwards, that Capt. Martini has had to go to Rome, deputed by the Marquis Antinori, to request assistance. Most of their baggage has been stolen or destroyed, and every possible obstruction thrown in their way.

THE additions to the Zoological Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from Mauritius, presented by Dr. J. F. Blackley; a Greater Black-backed Gull (*Larus marinus*) European, presented by Mr. W. J. Stebbing; two Common Barn Owls (*Strix flammea*) European, presented by Mr. Thomas May; a Long-eared Owl (*Otus vulgaris*) European, presented by the Misses S. E. P. and A. Warre; two Salt-water Terrapins (*Clemmys terrapin*) from Galveston, Texas, presented by Mr. J. R. Gillespy; two Yellow-billed Ducks (*Anas xanthorhyncha*) from S. Africa, two Plumed Colins (*Callipepla picta*) from California, received in exchange; two Bronze-winged Pigeons (*Phaps chalcoptera*) bred in the Gardens.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Aug. 28.—Vice-Admiral Paris in the chair.—The following papers were read:—Theorems relative to couples of segments having a constant length, by M. Chasles.—Sixth note on electrical transmissions through the ground, by M. Du Moncel. Placing two zinc plates in two wells 161 metres apart, one in a farmyard, the other on the border of a wood, and connecting them with wire and galvanometer, he got a strong current. He next made a couple with the two waters, separated by a porous vessel, and got a deflection of 80°, the electrode in the water from the farm well being positive. This water contained some sulphuretted hydrogen and organic matter; the other was pure; neither showed acid or alkaline properties. The action was peculiar to zinc electrodes (at least as regards direction of current). From other experiments he concludes that beyond 336 metres the resistance opposed by the water of a river remains nearly the same, whatever the distance of immersion of the plates; hence this resistance is probably indistinguishable from that of the ground at a distance less than 336 metres. Under the best conditions the resistance of the ground varies from 4 to 5 kilometres of telegraphic wire, and if wells or the like do not intervene in the communications it may sometimes be enormous.—On the periodic comet of d'Arrest, by M. Leveau. He gives an ephemerides to enable astronomers to observe this small comet on its return in 1877. (It was first observed in 1851, and its period is about 6½ years.)—Letter from M. Wolf to M. Le Verrier. M. Weber, at Peckeloh, on April 4 last, at 4.25 P.M., saw a round spot on the sun, which was seen without spot on the morning of that day, and also of the next day, at Peckeloh, Zurich, and Athens.—Observations on the Planet 165; positions of some variable stars, by Mr. Peters.—Stars near the pole star, by M. de Boe. Besides the known companion there are two others much nearer and fainter. He observed them first in 1869 and has this year verified their existence. They are probably subject to varying brightness and rapid movements round the principal star; and they are perhaps best seen with small objectives.—On alcoholic and acetic fermentation of fruits, flowers, and leaves of certain plants, by M. de Luca. Fruits, flowers, and leaves in a limited atmosphere of carbonic acid, hydrogen, or air, or in vacuum, undergo slow fermentation, liberating carbonic acid, nitrogen, and sometimes hydrogen, and forming alcohol and acetic acid, without intervention of any ferment. In a close vessel the phenomena are incomplete, owing to pressure of the developed gas; but, with ordinary pressure maintained, neither sugar nor starch will be found after the development of gas has ceased; in their place are alcohol and acetic acid in abundance. The hydrogen liberated is doubtless from decomposition of mannite, which is a sugar with excess of hydrogen.—Influence of pine forests on the quantity of rain which a country receives on the hygrometric state of the air and on the state of the soil, by M. Fautrat. Comparing the rain-fall for fourteen months on a pine forest and a sandy plain 300 metres off, he finds a difference of 83 mm. in favour of the former, or more than 10 per cent. of the rain-fall on the open ground (the difference was only 5 per cent. in the case of oaks and witch-elms). The annual difference in saturation was (in favour of the air above the pines) ten-hundredths. Of 757 mm. of water which fell, the forest ground received 471 mm.—M. Faye, in presenting Nos. 39 and 40 of *Astronomische Mittheilungen*, made reference to M. Wolf's researches on sun-spots and terrestrial magnetism. The last minimum was in 1867, and as the period is 11⅛ years, we should have looked for a minimum in 1878, instead of which it has occurred between the end of 1875 and beginning of 1876, showing a remarkable anomaly of more than two years. The variations of the needle are shown to follow the sun-spots with singular fidelity.

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THURSDAY, SEPTEMBER 21, 1876

ZITTEL'S HANDBOOK OF PALÆONTOLOGY

Handbuch der Palæontologie. Unter Mitwirkung von W. Ph. Schimper, Professor an der Universitat in Strasburg. Herausgegeben von Karl A. Zittel, Professor an der Universität in Munchen. Erster Band. Erste Lieferung; mit 56 Original-holzschnitten. Munich, 1876: R. Oldenbourg. (London: Williams and Norgate.)

A WORK bearing on its title-page the well-known names of the Professor of Geology in the University of Strasburg, and the Director of the Royal Palæontological Museum at Munich would, under any circumstances, command attention, but one addressed to so large and so varied a circle as that for which a handbook or text-book is ordinarily designed, becomes, under such auspices, especially noteworthy, and although the first part only has as yet appeared, it can scarcely be thought too soon to bring it under the notice of such of the readers of NATURE as do not habitually see Continental scientific publications. In few departments of science does there exist the same need for a modern text-book as in general palæontology, especially for a treatise suited to the requirements of the student--something broader in scope than the fashionable "science primers" on the one hand, and without the elaborate details of special memoirs on the other—but it is at the same time true that the satisfactory preparation of a manual embracing so wide a subject needs qualifications of an unusual sort. The opening part of the present work has therefore a hearty reception assured to it, nor if succeeding instalments bear out the promise of the first, can any reasonable anticipations be disappointed. The authorship of the book is to be apportioned in the following manner. It is to be completed in two volumes, the first of which, devoted to Palæozoology and containing also the Introductory matter is entirely in the hands of Prof. Zittel. Of the second volume, one division, that on Palæophytology, is undertaken by Prof. Schimper, and the other, on Historical Palæontology by Prof. Zittel.

The part before us commences with a chapter of Preliminary Notions, and then one on Geological Succession; these are followed by a very interesting Historical Summary of palæontological discovery, from the earliest allusions to fossils in the writings of the Greek historians, down to the present day. A fourth section is devoted to Biological Considerations, and this is succeeded by a classified Bibliographic List of standard works in the several departments of the subject. These together form the Introduction, and little need be said concerning it, except that it is all well done. It is worth while to quote a single passage from the biological section which well deserves the leaded type in which it is printed- it is on the question of "Species," and runs thus (page 46-the italics are our own) "All those individuals, or remains of individuals, are regarded as belonging to one species, which have a number of constant characters in common, and which, *independent of distribution in space or time*, constitute, as a whole, a well-defined form-group, which indeed may be connected by many passage forms (but not completely) with other form-groups." An excellent and practical definition in the face of the prevalent custom of re-naming the same zoological form every time it appears in a new area, or at a fresh geological horizon, and one worth enforcing, if it were only in the interests of the next generation of palæontologists. Were the principle embodied in it generally adopted, the exercise of common sense in the estimation of the biological significance of minor characters would be sufficient to clear our fossil-lists of hundreds, nay of thousands, of the superfluous specific names with which they are at present crowded.

Systematic Palæontology is introduced by an outline of zoological classification based on the arrangement employed by Claus in his "Grundzuge der Zoologie," in which the animal kingdom is primarily divided into seven sub-kingdoms PROTOZOA, CŒLENTERATA, ECHINODERMATA, VERMES, MOLLUSCA, ARTHROPODA, and VERTEBRATA. The portion of the Handbook now issued treats of the first of these—the Protozoa. This group is subdivided into three classes, MONERA, RHIZOPODA, and INFUSORIA. The Monera are but slightly represented amongst known fossils, and the Infusoria not at all, so that, practically, the part amounts to a synopsis of fossil Rhizopoda. Sponges, it is to be noted, are referred to the Cœlenterata, of which sub-kingdom they form the lowest section.

The MONERA are sufficiently treated in a few pages embodying a brief summary of the various researches on Coccoliths, Coccospheres, Cyatholiths, Discoliths, and other microscopical bodies of which the precise significance may still be regarded as more or less *sub judice*.

The class RHIZOPODA is subdivided into three orders—*Foraminifera*, *Radiolaria*, and *Lobosa*, the last-named having, of course, no fossil representatives. The *Foraminifera* are described, in brief, as Rhizopoda with many-chambered or single-chambered calcareous, or less frequently arenaceous or chitinous tests; the *Radiolaria* as Rhizopoda with differentiated sarcode-body, having central capsule, and very regular, radiated, silicious skeletons. A detailed account of the zoology and literature of each Order is given, and the subordinate groups are then treated *seriatim*. The arrangement of the Foraminifera is largely drawn from the labours of Messrs. Carpenter, Parker, and Jones, but it differs in two material points from any classification hitherto proposed, and to these it will be necessary briefly to allude.

In the arrangement proposed by the above-named English authors as well as in that of Prof. von Reuss, published about the same time, the Foraminifera were divided into two Sub-orders, *Imperforata* and *Perforata*, according to the condition of the test in respect to the minuter pseudopodial passages, and in so far no change is suggested. It has been customary hitherto to divide the *Imperforata* into three families characterised by "chitinous," "porcellanous," and "arenaceous" tests respectively. Dr. Zittel, after separating the chitinous forms, divides the remainder without reference to shell-structure, into two families—*Cornuspiridæ* and *Miliolidæ*, each of which contains both opaque-calcareous and sandy forms. The very names, as used to distinguish two large groups, are somewhat anomalous, as it may be clearly shown by the study of recent specimens, that the *Cornuspiræ* are only non-septate *Miliolæ*. Apart from nomenclature, there is perhaps

something to be said for this method of treatment, but the question is whether the difficulties it entails are not greater than those it is intended to avoid. The arenaceous and porcellanous types have one important character in common, in the imperforate condition of the test; and there is yet another peculiarity which some of the members of both groups possess not shared by the *Perforata*, namely, the tendency exhibited by such forms as tolerate brackish water (*Miliola* and *Trochammina*) to assume a more or less chitinous or membranous investment in proportion to the decreased amount of mineral constituents held in solution; whilst under similar conditions the shells of the more highly organised perforate forms (*Polystomella* and *Nonionina*) become thinner and more delicate, but never change their essentially calcareous nature. On the other hand, it can be easily shown that the *Globigerinida* have more points of connection with the arenaceous group than the *Miliolida* have, for whilst the latter furnishes but few examples with any approach to sandy shell-texture, the former has a number of types which might with good reason be associated with some which have hitherto been classed amongst the *Lituolida*, to form an intermediate group, calcareous and perforate under certain circumstances, arenaceous and imperforate under others.

The truth of the matter is that the variations of the Foraminifera are too multiform and the connection of the members of the Order one with another is too close to be well adapted for divisional classification, but they lend themselves readily and naturally to arrangement in linear series. Thus, in the first family of the English classification, MILIOLIDA, we find a large assemblage of forms of various degrees of complexity, but having, with trifling exception, compact, non-porous shells. In such forms as *Quinqueloculina agglutinans* and its fellows, the "porcellanous" overlaps the "arenaceous" series, rendering complete separation on the basis of shell-texture impossible. Next in order come a number of types essentially and invariably arenaceous—a series by no means uniform in the structure of the investment or even in the materials of which it is composed, but all composite, imperforate, and opaque. These give place to another intermediate set, partaking more or less of the characters of the "arenaceous" and the "perforate" groups, comprising such genera as *Endothyra*, *Valvulina*, *Textularia*, *Bulimina*, and the like, that are, it may be, clear-shelled and imperforate, sandy and imperforate, sandy externally but with a perforate shell as basis, or even hyaline and perforate, the mere size of the specimen having apparently much to do with the nature of the test. These supply any required number of transitional steps to the uniformly "perforate" types which constitute the highest group. We need not dwell further on this subject. To the systematist it is one of considerable difficulty, from whatever point it is viewed, and unless some better basis for classification than the minute structure of the shells of these little animals can be suggested, it may be a question whether an increase in the number of families by the recognition of an intermediate group, or possibly of more than one, would not be the course open to the fewest objections.

The second point that demands notice is the reconstruction of the important family NUMMULINIDA; for practically the characters assigned to it in the work before us would result in nothing less than reconstruction, if literally read. It is not needful to reprint the entire paragraph relating to the subject, for its essential element may be stated in few words, viz., the reliance on a complicated interseptal canal-system, as the characteristic feature of the Nummuline group. As one consequence of this limitation, and it is only one out of many that must ensue if consistently carried out, the genera *Amphistegina* and *Archædiscus* are placed amongst the *Globigerinida*. That there is some *primâ facie* ground for the change may be taken for granted, or it would not have found favour with so competent an observer as the author of the Handbook, but the more it is investigated the more we think it will appear that reliance on a single character of this sort is suited to the exigencies of an artificial system, rather than to the exposition of natural relationship. As the point in question is one of great importance, and involves the principles on which accepted methods of classification are based, it may be worth while to illustrate its general bearing by one or two instances of the results that would follow the adoption of a hard and fast definition of the nature proposed. Take for example the well-known genera *Polystomella* and *Nonionina*—types so closely related that the latter is often treated as a mere sub-genus of the former, and is perhaps best so regarded. In its higher modifications *Polystomella* has a very complicated canal-system, whilst no trace of such organisation has ever been traced in *Nonionina*. On the other hand, turning to the GLOBIGERINIDA, we find that *Rotalia* (proper) in its highest modifications has also a well-defined and complex canal-system, and the same, moreover, is easily recognised in *Calcarina*; so that this character, even according to Dr. Zittel's arrangement of genera, is not an exclusive feature of the NUMMULINIDA. Prof. W. K. Parker, than whom few have better right to be heard on such a point, regards *Amphistegina* (though a true generic type) as bearing a relation to *Nummulina*, similar in kind if not in degree to that which exists between *Nonionina* and *Polystomella*. It is true that neither in *Amphistegina* nor in *Archædiscus* has any true canal-system been demonstrated, but it must be recollected of the latter type that it has no septa, and it is possible that the double tubulation occasionally observable in its supplementary skeleton may represent this special organisation in a rudimentary condition. That *Polystomella* is a more highly organised type than *Rotalia*, and *Nummulina* presents a distinct advance upon either, and that in *general* terms the fact may be demonstrated by the relative complexity of the structure of the test, is hardly open to question. What is here contended for is this—that throughout the Foraminifera in each group comprising the modifications of a single central type, or of two or more closely allied types, there may be traced a regular series of subordinate forms gradually increasing in complexity of organisation, and that these cannot be separated in a system of classification without doing violence to the order of nature. In the types to which reference has already been made, such a sequence is easily found. In *Rotalia*, the minute thin-shelled, brackish-water *R. nitida* presents the very simplest morphological characters; *R. Beccarii* with its double septal walls marks a distinct advance, and, omitting a multitude of intermediates, *R. Schroeteriana* exhibits the highest development with a complete interseptal canal-system. In *Poly-*

stomella the most elementary variety of the type is found in the thin-shelled, simple *Nonionina depressula* of brackish-water pools, whilst *N. asterizans* and *Polystomella crispa* lead up to the complex *P. craticulata*, which is the parallel of the highest Rotalians. In like manner with *Nummulina*, though, as might be expected, the successive steps of differentiation are more distinct, and, as far as our present knowledge goes, further apart, it appears more consonant with analogy and more in accordance with natural order to regard *Archædiscus* and *Amphistegina* as closely related forms of inferior organisation leading up to the perfect type. The striking similarity in the general minute structure of the shell in these reputed Nummuline forms is confirmatory evidence not without value. The alterations rendered necessary by the adoption of the "presence of a canal-system" as the essential character of the family, could not stop where Dr. Zittel has left them; *Nonionina* and *Fusulina* would have to be transferred to the GLOBIGERINIDA, whilst *Calcarina*, *Tinoporus*, and some of the true *Rotaliæ* must under the restricted definition be severed from their natural allies to be placed amongst the NUMMULINIDA—changes that would find but little favour amongst students of the Rhizopoda.

There are many other little points in connection with the treatment of the Foraminifera that are open to criticism, favourable or otherwise, but as they do not affect the general usefulness and value of the work, it is needless to extend an already lengthy notice by their examination.

The RADIOLARIA, better known perhaps under Ehrenberg's name "Polycystina," form a much more manageable Order, and one which, in the present state of our knowledge, lends itself comparatively readily to artificial subdivision. The literature of the subject too is comparatively limited—that of the successive stages of investigation being summarised in the standard memoirs of Professors Ehrenberg, Johannes Muller, and Ernst Hæckel. The classification adopted by Prof. Zittel is with but little modification that elaborated by Prof. Hæckel for his magnificent monograph. The entire Order is divided into fourteen principal Groups, founded for the most part on the geometrical characters of the silicious skeleton. Out of the fourteen Groups, notwithstanding the enormous number of individuals and of species found in the early and middle Tertiary deposits of Barbados, Bermuda, North America, and the Mediterranean borders, only about one-half are known to have fossil representatives.

The Radiolaria make their appearance at a much later period of the earth's history than the Foraminifera and the part they have had to play in the formation of successive geological deposits has been a much less important one. Doubtful specimens have been found as far back as the Triassic beds of St. Cassian, but of too obscure a nature to yield satisfactory evidence as to geological range, and the same may be said of some that have been described of Jurassic age. In the Upper Chalk, however, well-defined and characteristic forms have recently been discovered by Dr. Zittel. In the earlier part of the Tertiary epoch the group assumes considerable importance, and from that time to the present Radiolaria have formed a frequent if not a constant element of the fauna of deep water.

The first part of the "Handbook" refers, in the main, to fossils belonging to one division of the Animal Kingdom, and it has therefore been necessary to dwell on points in which the mode of treatment differs from that which has hitherto prevailed, but the questions which have been adverted to in detail have a special and limited bearing, and do not materially affect the work in its wider aspect as a manual of palæontology. Of its excellence, when complete, as a student's text-book, and of its prospective value to the working palæontologist, the present instalment gives abundant promise.

There is but a word to add on the illustrative woodcuts. To those who recollect the beautiful drawings that accompany that section of the "Novara-reise," which is devoted to the Foraminifera of Kar Nikobar, the name of Dr. Schwager will be sufficient guarantee for accuracy and finish, and it is only needful to say that the draughtsman's hand has lost none of its cunning and that in the present work the illustrations, which are for the most part new, are singularly apt and effective, though, in the copy before us, occasionally somewhat marred by defective printing.

H. B. BRADY

OUR BOOK SHELF

Handbooks for the Glasgow Meeting of the British Association.—1. "Notes on the Fauna and Flora of the West of Scotland." 2. "Catalogue of the Western Scottish Fossils." 3. "Notices of some of the Principal Manufactures of the West of Scotland." (Glasgow: Blackie and Son, 1876.)

AS there are satisfactory guide-books to Glasgow and the West of Scotland already in existence, it would have been superfluous in the Local Committee to have compiled another general work of the same kind. It was, however, a happy idea to publish the three volumes which we have only now received, as they contain just such special information as cannot be readily obtained, but which it is to be supposed the many votaries of science who were recently assembled in Glasgow would be glad to be furnished with. The volumes are well printed, of a handy size, and, so far as we have been able to test them, carefully compiled by competent men. In the volume devoted to the fauna and flora, Mr. E. R. Alston describes the mammalia, Mr. Robert Gray the birds, Mr. Peter Cameron the insects, Mr. James Ramsay vascular flora, and Dr. J. Stirton the Cryptogamic flora. To vol. ii. is prefixed an Introduction by Prof. Young, on the geology and palæontology of the district, the catalogue itself being compiled by Messrs. James Armstrong, John Young, F.G.S., and David Robertson, F.G.S. This volume is illustrated with four plates of fossils. In the volume devoted to manufactures, Mr. St. John V. Day writes on the iron and steel industries, Mr. John Mayer on the engineering and ship-building industries, Mr. James Paton, Curator of the Glasgow Industrial Museum, on the textile industries, and Prof. John Ferguson on the chemical manufactures. Considering the haste with which these volumes must have been compiled, they are wonderfully complete and well arranged, and if the publishers are careful to keep them up to date and extend them in a new edition, they might become of permanent value. Prefixed to each volume is a sketch map of the country surrounding Glasgow, with its general geological features.

The Tree-lifter; or, A New Method of Transplanting Forest Trees. By Col. George Greenwood. Third Edition. (London: Longmans, Green, and Co., 1876.)

THIS is a book of some two hundred and thirty odd pages, eleven pages of which are devoted to a description of the

tree-lifter and of its advantages in transplanting large trees. The principle of transplanting trees with a large ball of earth attached to the roots is, however, so well known, and tree-lifters of similar construction to that here described are now so generally used, that we follow the example of the author in his brevity, and simply dismiss this part of the subject which he calls the "practical part of transplanting," and turn to Part 2, which is devoted to the "theory of transplanting, or physiology of trees in reference to transplanting." It is apparently for the purpose of recapitulating and condensing the views of various authors of acknowledged reputation in the several branches of vegetable physiology, and of expressing his own opinions thereon, that the author has put this book together, all that is really directly connected with the title being contained, as we have before said, in the first eleven pages. The author, however, at the beginning of Part 2, candidly says: "Before entering on physiology, I would say one word to defend myself from the charge of egotism and plagiarism. When I mention Sir Humphry Davy, I may say that immortal names are among those who have written on the physiology of trees; yet so much doubt and difference prevail among the authors on the subject, that one cannot adopt a single opinion without opposing many, held by minds, perhaps, as clear and comprehensive as Sir Humphry's. It is, then, to save the reader's time if I lay down as certain what men have doubted or controverted, or if I use the words, 'I think this,' or 'I think that,' in stating other people's opinion."

Space will not permit us to follow the author through all his reasonings; it will suffice to mention that no less than forty-one pages are given to the consideration of the subject of the course of the sap, in which the author tilts at several well-known English and Continental botanists whose theories are adverse to his own. Lindley is the most recent authority quoted in the original edition, and the opinions of later writers have not been embodied in subsequent issues. What we have already said will show the character of the book. The style of writing may be gathered from the first paragraph in the chapter on the course of the sap, where the author says: "However much we may dispute on *how* the sap gets into the tree, we shall all agree that it *does* get in somehow; and but for Dr. Lindley, I believe we should all agree on the *course* which it then takes." Further on, in connection with the theories of the contraction and expansion of the wood, caused by alternating heat and cold, and of the pumping action from the motion caused by wind, Col. Greenwood writes: "Look into the hot-house and the hot-bed. In these neither of these causes exists. Not a breath of wind enters; nor is any alternation of heat and cold allowed. Yet in these the ascent of the sap is freest. And if we look out of doors, I should say that the sap would be a slow traveller if its ascent depended on wind and cold. Here, then, I cannot back the favourite, and have a sort of blind leaning for *Turgescence*, or Swelling, a dark horse, certainly, and I am all in the dark about him myself;" and the author is in a similar state of gloom upon other points besides.

Practical Portrait Photography. By Wm. Heighway. (London: Piper and Carter, 1876.)

THE author of this little book of 152 pages has endeavoured to "provide simple and intelligible rules of working," as he states in his introduction, so that those who take up photography as an art should be helped over a number of difficulties certain to occur, and not always provided against in more ambitious works. The lessons chiefly enforced are cleanliness and accuracy in preparing the requisite solutions, and method in carrying out the rest of the processes; though these lessons may seem trite to the regular student of science, they are no doubt much needed amongst photographers who are not at the same time practised chemists.

The necessary instructions are well and carefully given, and the author has omitted no point of importance, taking the reader *seriatim* through every detail, from cleaning the glass plate to finishing the paper print.

We notice some errors in chemistry, where the author has given reasons for some of the processes, which we hope will be corrected in a future edition. R. J. F.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

On the Discovery of Palæolithic Implements of Interglacial Age

THE opinion that palæolithic man was a post-glacial being has been steadily losing ground among certain geologists whose studies render their opinions of considerable weight. Mr. Pengelly and Prof. Ramsay have stated their conviction that the old stone folk may have witnessed the commencement of glacial conditions, and have been driven south by the increasing severity of the climate. Prof. Dawkins has expressed his belief that while our rude ancestors hunted the elephant, glaciers still lingered in our mountain-valleys. Mr. Tiddeman goes further, and ascribes to them an inter-glacial age, and, as it seems to me, proved his point by the discovery of implements and a human bone beneath glacial-clay in the Settle Cave. Mr. James Geikie boldly advanced the opinion that *all* our palæolithic implements are of inter-glacial age, and an intimate knowledge of the glacial beds and gravels of the central and eastern counties led me independently to a similar conclusion. In making this last statement I particularly desire it to be understood that no claim is preferred to the theory as my own, for while I was almost fearful of my temerity in even thinking such things, my friend Mr. Geikie had brought his great stores of knowledge to bear upon the point, and has made it peculiarly his own. Nevertheless the fact that two geologists working independently in different districts should arrive at similar conclusions is no mean argument in our favour. The evidence upon which my convictions are based is given in my "Geology of the Fenland," and in my "Manufacture of Gun-flints," &c., to be shortly issued by the Geological Survey, and in the forthcoming edition of the "Great Ice Age."

Mr. Geikie has proved, and the work of Mr. Tiddeman, myself, and others, has confirmed the observations that the glacial epoch, instead of being an uninterrupted period of cold, was one of fluctuating climate, there being known at least four ice ages with intervening cold, mild, and warm epochs. The greatest severity of cold took place towards the early part of the Great Ice Age, and the great chalky boulder-clay which extends nearly to the Thames was then formed; no subsequent ice-sheet having left its traces further south than Lincolnshire. Travelling northwards from East Anglia we find this boulder-clay running under the purple boulder-clay, and this again overlaid still further north by a yet newer glacial bed. These are well-known facts accepted by all geologists, but as the old chalky boulder-clay has unfortunately been named the "upper" boulder clay, it has been supposed to mark the close of the glacial epoch, whereas it is only "upper" so far as East Anglia is concerned, and merely marks the last glaciation of that area, the more northern districts having been more than once glaciated since then. The East Anglian "upper" boulder-clay is probably as old as the Lancashire "lower" boulder-clay.

In consequence of this confusion of terms, the beds which overlie the chalky boulder-clay have been confidently relegated to post-glacial times, whereas all that can be determined by this superposition is that they are "post-boulder-clay." From valley and other gravels occupying such positions, great numbers of palæolithic implements have been obtained, especially from the basins of the rivers Lark and Little Ouse. Wherever bones are found in these gravels they belong to what Prof. Dawkins calls the pleistocene, and not to the pre-historic fauna; and this mammalian fauna is continued into the estuarine gravels of the Fenland, which contain extinct shells, such as *Cyrena fluminalis*, a shell which has often been found in gravels yielding palæo-

ithic, but never in beds yielding neolithic implements. As we travel northwards, say to Hessle, these *Cyrena*-bearing gravels are seen to underlie boulder-clay newer than the upper one of East Anglia; and in cave deposits still further north, beds yielding the same pleistocene mammals appear in similar situations, notably in the Victoria Cave at Settle. Now bearing in mind that in East Anglia, &c., where these beds are best developed, there has been no subsequent glaciation to sweep them bodily away, or show their age relatively to the glacial epoch, it seems to be a legitimate deduction that they are of inter-glacial age, when we find that to the north, wherever fragments have escaped destruction, they are overlaid by glacial beds. This is the conclusion to which Mr. Tiddeman arrived from a study of the Victoria Cave deposits and an intimate acquaintance with the glacial phenomena of the district, and my own work in the Fenland and East Anglia led me to a similar result. Mr. J. Geikie has, however, done more than any one to develop this idea, and was the first to propound it. He claims, then, that no palæolithic implement is of post-glacial date; and when we reflect upon the vast changes which have occurred since palæolithic times in the physical configuration of the country, in the mammalian fauna—changes which are even impressed upon the stable mollusks—the theory appears more than probable, and the difficulties which surround the post-glacial hypothesis steadily increase.

Palæolithic implements, however, are not all of one age (it would be strange indeed if they were), though it is very difficult to discriminate their relative antiquity. I have been much struck with the aged aspect of certain of the ruder tools as compared with some of the better finished ones and with the stones in the gravel in which they occur, and this gave me hopes of tracing such tools to an older deposit, a desire which has been abundantly fulfilled, and remarkably confirms my friend Mr. J. Geikie's bold surmise.

Here and there along some of the minor valley sides around Brandon are preserved patches of brick-earth, which are valuable as affording the only workable clay in the district. Whenever these beds are well exposed they are seen to underlie the chalky boulder-clay. Of this there cannot be the slightest doubt, for the glacial bed is typically developed and not in the slightest degree re-constructed. In these beds I have been so fortunate as to find palæolithic implements in two places; and in one of them quantities of broken bones and a few fresh-water shells. The implements are of the oval type, boldly chipped, but without any of the finer work which distinguishes the better made palæolithic implements. Although it would be rash to lay too great a stress upon the characters of these implements, it is, nevertheless, worthy of remark that they do belong to the crudest type. Equally rough specimens are found in the gravels above the boulder-clay and even among neolithic finds, still these very antique implements certainly do seem to belong to an earlier stage of civilisation if we regard them as examples of the best workmanship of their makers.

The interest attaching to these specimens lies in their exceeding antiquity—an antiquity greater than can be ascribed with certainty to any others. I have shown this boulder-clay to belong to the earlier part of the ice age, and beneath it these tools were found. I am not yet certain whether they belong to the so-called "middle glacial" series of Mr. Searles Wood, jun., to a somewhat newer date, or to a preceding period, for the beds lie directly upon the chalk. This much, however, is certain, that they conclusively prove man to have been a denizen of our land before the culmination of the glacial epoch.

Another point is deserving of notice. The tools are decidedly of palæolithic aspect—the difference between them and those which overlie the boulder-clay is slight in comparison with the differences between the latter and neolithic implements. Who shall say how long East Anglia was swathed in ice? Yet that interval was not long enough for man to advance greatly in his manufactures, and it appears to me we have here another argument in favour of the glacial age of all palæolithic tools and against the theory which relegates them to after the close of the ice age. It seems to bring the brick-earth tools and the gravel implements closer together, and withdraw them still further from the newer stone age.

As soon as the bones are examined and the survey of the brick-earths completed, I hope to write more fully upon this question, and here only indite a few preliminary notes in the hope that they may prove interesting to brother geologists.

SYDNEY B. J. SKERTCHLY

The Inverse Rotation of the Radiometer an Effect of Electricity

In my communication published in NATURE, vol. xiv. p. 288, I endeavoured to show that the direct rotation of the radiometer was an effect of electricity. Before attempting to explain the inverse rotation it will be necessary to expound briefly some new facts which my electroscopic researches have led me to establish.

In order to ascertain the electric state of their inner surface, I exposed to solar radiation glass receivers such as are used for the air-pump. By means of the proof plane and electroscope I found that this surface was electrified negatively, and even to a greater degree than the exterior. This excess of energy I attribute to the numerous reflexions from the interior. If, however, we hold one of these electrified receivers near the Bohnenberger electroscope, taking care that it does not come in contact with it, the electroscope at once indicates the presence of *positive* electricity. As both the outer and inner surfaces are negatively electrified, this phenomenon must be attributed to the electricity developed in the interior of the glass itself by its molecular polarisation and feeble conductivity. The following experiment confirms this explanation. If we remove from the exterior by means of the proof-plane a portion of the negative electricity and then approach, as before, the globe to the electroscope, a remarkable increase of positive electricity is at once shown. The same results are observed in the radiometer.

I next examined the electric state of the exterior of the radiometer globe when placed in partial obscurity and moistened with ether. There are no signs whatever of electricity as long as the inverse rotation continues, but as soon as the direct rotation commences—on account of the obscure radiations given forth by the surrounding bodies—positive electricity manifests itself and rapidly increases. While in this state I exposed the radiometer to solar radiation, and I found that this positive electricity remains quite a long time, and that, notwithstanding the positive charge on the exterior, the direct rotation continues with its usual rapidity.

The fact last-mentioned enabled me to determine, by experiment, the electric state of the inner surface of the radiometer globe. Only two suppositions can be made in regard to it: either the electric state of the inner surface is dependent by means of molecular polarisation upon the electric state of the exterior, or it is independent. In the first supposition the interior face is electrified positively when the exterior is electrified negatively, and *vice versâ*. The second supposition may be divided into three hypotheses, for we can admit that the interior is constantly, under the same circumstances, either neutral, or negative, or positive. Hence we have in all four hypotheses, *à priori*, viz. :—

1. Inner surface is dependent upon electric state of exterior.
2. Inner surface is independent and neutral.
3. Inner surface is independent and negative.
4. Inner surface is independent and positive.

Now of these four hypotheses the fourth alone is verified by experiment. This I have established as follows:—

In one series of experiments I charged the exterior of the radiometer with positive electricity by exposing it to solar radiation.

In a second series I charged the same surface with positive electricity by exposing it to solar radiation after moistening it with ether.

Each experiment comprised two operations. I touched a certain number of times the exterior of the glass globe with the proof-plane and I carefully observed the electroscopic signs of the Bohnenberger electroscope when brought in contact with the proof-plane; then I approached to the electrometer the glass globe which had been partially discharged by the preceding experiment, and I again observed the signs given by the electroscope. In the case that one of the first two hypotheses expresses the real state of the inner surface of the radiometer under the influence of radiation, on approaching the glass globe we should have, in both series of experiments, electroscopic signs of equal intensity for equal electric charges of the exterior surface, manifested by the equality of those of the proof plane. Now this does not take place. In my experiments on the approach of the globe the electroscopic signs in the second series surpass in intensity those observed in the first series. These results agree perfectly with the fourth hypothesis, but are in open disaccord with the third. Any one can easily see this, with a little attention, by considering the layers of electricity produced in the interior of the glass walls by molecular polarisation. The fourth

hypothesis is, then, the true one, and the inner surface is electrified positively.

The explanation of both the direct and inverse rotation follows naturally from these facts and those communicated in my former note. For since the inner surface, when exposed to luminous or calorific radiations, is electrified positively, the direct rotation is a necessary consequence of the attractions and repulsions which this positive electricity exerts upon the free electricity of the vanes. This rotation continues when the radiometer is surrounded by light, because a perfectly homogeneous layer of electricity upon the inner surface is almost impossible.

The inverse rotation occurs in two circumstances—

1. When the instrument, having been exposed to radiation which produces a direct rotation is allowed to cool slowly.

2. When the radiometer at the ordinary temperature is cooled suddenly, for instance, by moistening it with ether.

In the first case, the electricity which the globe acquires when exposed to radiation disappearing very slowly, as experiments show, an inversion of the movement can be produced by an inversion in the signs of the electricity of the vanes. In fact, in accordance with the principle of reciprocity, the emission of the radiations gives rise in the vanes to a development of electricity equivalent and contrary to that which absorption has produced there. By this development of electricity the vanes would return to their neutral state if the electricity produced by absorption had not passed in part from the vanes into the rarefied gas of the globe. Now this passage took place with a greater energy as the rotary movement of the vanes had renewed more frequently the mass of air in contact with them. Hence the electric effect of the emission will be to change the signs and to diminish the charge of free electricity of the vanes.

In the second case, where the cooling is produced by moistening the exterior, the globe remains in its neutral state. For, as I have above remarked, during the whole time of the inverse rotation, the cooled surface of the globe gives no signs of electricity. It appears that the cooling itself is not capable of producing electricity, but that the passage of a radiation through the surface is absolutely required. In these conditions the vanes become charged with negative electricity upon the dark, and positive upon the bright side, by reason of the emission, at the same time that the radiations given forth by the vanes and absorbed by the inner surface of the glass globe electrify the latter positively.

Thus the electric theory of the radiometer explains quite well the principal phenomena which have been observed up to the present time. I hope to make, hereafter, a study of all the particular movements which different observers have noted in the accounts of their experiments. I will only say now that the most remarkable of them, viz., the rotation of the radiometer globe, when an obstacle is put to the rotation of the vanes, as discovered by Schuster, is in entire conformity with the above theory, while it constitutes a very serious objection to the hypothesis of mechanical impulsion by radiation.

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A Rudimentary Tail

A DAY or two ago a curious and interesting abnormality came under my notice, which, I think, deserves mention. I was examining the back of a girl, aged about eight, when I saw over the lower part of the sacrum, in the middle line of the back, a small hole, that, on the first glance, seemed like the opening of an old sinus. I was told, however that it had been present since birth, and I then looked at it more carefully. It had a direction downwards and somewhat forwards, and consisted of a reflection of the skin entering a more or less circular depression, about ¼ inch in diameter, and about ¼ inch deep. Not quite ¼ inch below its lower border could be felt the pointed extremity of the coccyx, which, instead of having its usual form, curved backwards and rather upwards. On stretching the skin downwards, that portion of it entering the depression or hole was raised, coming out like the top part of the finger of a glove which had been pressed down into the lower part, and a small prominence, about the height of the diameter of a pea, stood up from the surface; and this little sheath was found to cover and exactly fit the sharp end of the coccyx. The resemblance this bore to a rudimentary tail was sufficiently striking.

Jersey ANDREW DUNLOP

The Æolian Formation on the Lancashire Coast

IN the absence of large works on the subject, has your recent Waterloo correspondent seen the Survey memoir of the district around Southport in which the phenomena of wind driftage are treated in a brief yet quantitative manner? The efficient way in which pebbles and shells—as of *Mactra stultorum* (with which the shore is so plentifully covered)—especially when the convex side of a valve is presented vertically towards the direction of the storm winds, protect a small area to leeward, forming a miniature crag-and-tail arrangement, would seem to suggest that a solid screen offering an unbroken surface to the action of the wind, and at some distance from the region threatened, would be far more useful than the present expedients of growing marram grass, &c., to consolidate the dunes, or of planting lines of bare stakes. Practical men would easily devise a cheaply constructed barrier of old ship-timber faced with ling or other accessible material, or perhaps use the sand-hills themselves when armoured with tabular blocks of stone made on the spot by some such process as employed in the construction of the sea-walls of the Suez Canal. Land sold for building plots on exposed points ought surely to have some adequate defence against the devouring sand.

WILLIAM GEE

Manchester, Sept. 15

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF 1885, SEPT. 8-9.—The following elements, though approximate only, will suffice to give a pretty fair indication of the circumstances under which the totality of this eclipse will take place:

Conjunction in R.A., 1885, Sept. 8, at 9h. 18m. 58s. G.M.T.

	°	′	″	
R.A.	167	25	39	
Moon's hourly motion in R.A. ..		34	30	
Sun's ,, ,, ...		2	15	
Moon's declination	4	30	41	N.
Sun's ,, ...	5	23	40	N.
Moon's hourly motion in declination ...		10	58	S.
Sun's ,, ,, ,, .		0	57	S.
Moon's horizontal parallax		59	43	
Sun's ,, ,, ...		0	9	
Moon's true semi-diameter		16	16	
Sun's ,, ,, ...		15	54	

Hence the central and total eclipse begins upon the earth in long. 156° 54′ E., lat. 40° 54′ S., and ends in long. 75° 33′ W., lat. 74° 38′ S., and the sun is centrally eclipsed at apparent noon in long. 138° 39′ W., lat. 57° 40′ S.

The following are also points upon the central line:—

Long.	Lat.	Long	Lat.
173° 26′ E.	40° 28′ S.	177° 58′ W.	41° 23′ S.
175 3 E.	40 34	171 59 W.	42 39 S.
177 33 E.	40 46		

The semi-diameter of the shadow in these longitudes is about 55′. It would therefore appear that observations are not likely to be made to any useful purpose, except in the southern part of the northern island of New Zealand, and here the sun will have no great elevation above the horizon. If we calculate from the above elements directly for Wellington, assuming the longitude of this place 11h. 39m. 20s. E., and its latitude 41° 17′, we find—

	h.	m.	s.		
Partial eclipse begins Sept. 9 at	6	18	0	A.M.	Mean times at Wellington.
Total ,, begins ,,	7	42	22	,,	
Total ,, ends ,,	7	43	0	,,	
Partial ,, ends ,,	8	58	0	,,	

And therefore the duration of totality 38 seconds only, with the sun at an altitude of 15°.

Calculating similarly for one of the points upon the central line, some fifty miles north of Wellington, or long. 175° 3′ E., lat. 40° 34′, the totality is found to commence at 7h. 41m. 31s. A.M., local mean time, and to continue 1m. 54s., with the sun at an altitude of 16°.

At Wellington the sun rises at 6h. 21m.

AN INTRA-MERCURIAL PLANET (?).—A second letter from Prof. Rudolph Wolf, of Zurich, giving further particulars relating to M. Weber's observations at Peckeloh, near Münster, on April 4, 1876, was communicated by M. Leverrier to the Paris Academy on the 11th inst. The sky had been cloudless up to noon, and neither spot nor *facula* was remarked, though the sun's disk was examined three or four times, according to M. Weber's custom. After noon the sky clouded until between 4^h and 5^h, when it cleared in places, and the sun was visible from twenty to twenty-five minutes. Utilising this interval, "M. Weber ne vit pas de facule, quoiqu'il eût promené la lunette sur toute la circonférence du soleil. Tout à coup un petit disque bien arrondi de 12 secondes d'arc se montra. Il se trouvait à 11 secondes de temps du bord oriental, et à la même distance au nord de l'equateur céleste (*sic*). L'astronome eut le temps d'examiner de très-près le voisinage de la tache, et nulle part il n'aperçut le plus imperceptible mouvement de facule, nulle part un nuage avoisinant. Seul le petit disque foncé se détachait sur le fond solaire."

The sky soon after clouded, and it was only at five o'clock on the following morning that it was possible to ascertain that "the phenomenon had disappeared from the surface of the sun." The Peckeloh observation was made at 4h. 25m. P.M., mean time at Berlin. It will be remarked that the observation leaves something to be desired as regards clearness.

The 1st, 2nd, and 3rd of next month are dates when it is desirable the sun's disk should be closely examined for any abnormal spot.

THE BRITISH ASSOCIATION

AMONG the later discussions of the meeting no doubt that which has excited most general notice was the debate on Prof. Barrett's paper "On Certain Abnormal Conditions of Mind." There can be little question that in one sense it dealt with subjects suitable for the department of Anthropology, and the scientific repute of Mr. Crookes, Mr. Wallace, Lord Rayleigh, and Prof. Barrett, necessitates the careful examination of anything they may bring forward. But it is doubtful whether the interests of science are best served by the introduction of subjects which are sure to provoke heated and unscientific discussion at a mixed meeting like that of the Association. Dr. McCann did not obtain very much favour for his ill-judged and extravagant scheme of endowed research which he propounded. A good suggestion was thrown out by one of the foreign visitors at the Lord Provost's splendid banquet to the principal members of the Association, in favour of close union and inter-communication between the British and similar Associations in other countries.

The General Committee passed the following resolution relative to the proposed museum of scientific instruments:—"That the Council be requested to take steps to urge upon her Majesty's Government the advisability of forming a museum of scientific instruments and chemical products, as suggested in the memorial of June last to the Lord President of the Council." The Committee also approved a recommendation that in future the presidents-elect of the various sections be invited to confer with the general secretaries, preparatory to the issue of the first number of the daily *Journal* at each meeting, to arrange the order in which the sectional addresses shall be delivered. Thus members may have an opportunity of hearing more than one sectional address.

The following is a list of the grants made at this meeting for scientific purposes; the name prefixed is in each case that of the person entitled to call upon the treasurer for the amount:—

	£
Mathematics and Physics.	
*a*Everett, Prof.—Underground Temperature	50
*a*Stokes, Prof.—Reflective Powers of Silver and other Substances (renewed)	20
Thomson, Sir William.—Measurement of the Lunar Disturbance of Gravity	50
*a*Tait, Prof.—Thermoelectricity (renewed)	50
*a*Cayley, Prof.—Publication of Tables of Elliptic Functions	250
*a*Joule, Dr.—Determination of the Mechanical Equivalent of Heat	100
*a*Glaisher, Mr. J.—Luminous Meteors	30
Forbes, Prof. G.—Observation of Atmospheric Electricity in India	15
Chemistry.	
*a*Allen, Mr.—Estimation of Potash and Phosphoric Acid.	20
Wallace, Dr. W.—Light from Coal Gas	20
*a*Clowes, Dr. F.—Action of Ethyl Bromo-Butyrate on Ethyl Sodaceto-acetate (renewed)	10
*a*Armstrong, Prof.—Isomeric Cresols and the Law of Substitution in the Phenol Series (renewed)	10
Hartley, Mr. W. N.—Double Compounds of Cobalt and Nickel	10
Brown, Prof. Crum.—Quantitative Estimation of Atmospheric Ozone	15
Hartley, W. N.—Liquid Carbonic Acid in Minerals	20
Geology.	
*a*Evans, Mr. J.—Kent's Cavern Exploration	100
*a*Lubbock, Sir J., Bart.—Exploration of Victoria Cave, Settle	100
*a*Evans, Mr. J.—Record of the Progress of Geology	100
*a*Hull, Prof.—Underground Waters in the New Red Sandstone and Permian	10
*a*Herschel, Prof.—Thermal Conductivities of Rocks	10
*a*Bryce, Dr.—Earthquakes in Scotland	10
Topley, Mr.—Sub-Wealden Exploration	100
Biology.	
Gamgee, Prof.—Physiological Action of Ortho-, Pyro-, and Metaphosphoric Acids	15
Hooker, Dr.—Report on the Family of the Diptero-Carpeæ	20
*a*Stainton, Mr.—Record of Zoological Literature	100
*a*Huxley, Prof.—Table at the Zoological Station at Naples	75
*a*Lane Fox, Col.—Exploration of Ancient Earthworks (renewed)	25
Lane Fox, Col.—Instructions for the Use of Travellers	25
Statistics and Economic Science.	
*a*Farr, Dr.—Anthropometric Committee (partly renewed)	100
*a*Hubbard, Right Hon. J. G.—Common Measure of Value in Direct Taxation	10
Mechanics.	
*a*Froude, Mr. W.—Instruments for Measuring the Speed of Ships (partly renewed)	50
Thomson, Sir William—Secular Experiments on the Elasticity of Wires	100
	£1,620

a Reappointed.

At the concluding general meeting Mr. Griffith read the list of grants, and stated that 2,731 tickets had been sold, producing 2,983*l*. In detail, there had been present 211 old life members, 31 new life members, 318 old annual members, 208 new annual members, 1,243 associates, 696 ladies, and 24 foreign members. Sir John Hawkshaw moved a general vote of thanks to the local authorities and officials, especially mentioning Lord Provost Bain, Sir James Watson, Mr. Grahame, Dr. Blackie, and Mr. J. R. Napier. He said that the Lord Provost's kindness and geniality of disposition, his intelligence, and his power of unlimited work, were most remarkable. Capt. Galton, in seconding the motion, said he had never come in contact with a more energetic local committee.

The hospitality displayed at some of the excursions was magnificent, and the foreign visitors had been most cordially received. Prof Stokes, of Cambridge, proposed thanks to the University of Glasgow for the very great accommodation it had afforded to the Association; the motion was seconded by Dr Carpenter. Sir William Thomson proposed the vote of thanks to the President. He thought Dr. Andrews's presidency would be beneficial to the Association in many ways. In his address there were many things the serious and permanent consideration of which would prove most beneficial to the progress of science and of higher education in the country. Dr. Allen Thomson, the President-Designate for 1877, seconded the motion. Dr Andrews, in responding, expressed his gratification at the scientific character of the meeting, which he thought, would bear comparison with any other. All the sections had been above the average, and in Section A numerous papers of no ordinary importance were read. He referred especially to a paper by Dr Kerr of Glasgow, who had followed up one of the most difficult researches of Faraday, and had presented a paper of great originality and extreme value. There had been little that was sensational in their proceedings, but he believed even the public at large would greatly prefer true scientific work to excitement.

This meeting has been notable for the attendance of eight ex-presidents, viz., Prof Stokes, Dr Carpenter, Sir William Thomson, Prof A W Williamson, Sir John Hawkshaw, Dr. Hooker, Dr Lloyd, and the Duke of Argyll.

REPORTS

Report of the Committee for Testing Experimentally the Exactness of Ohm's Law, drawn up by Prof Clerk Maxwell. The statement of Ohm's law is that for a conductor in a given state the electromotive force is proportional to the current produced.

If we divide the numerical value of the electromotive force by the numerical value of the current the quotient is defined as the resistance of the conductor, and Ohm's law asserts that the resistance, as thus defined, does not vary with the strength of the current. The difficulty of testing the law arises from the fact that the current generates heat and alters the temperature of the conductor, so that it is extremely difficult to ensure that the conductor is at the same temperature when currents of different strength are passed through it.

Since the resistance of a conductor is the same in whichever direction the current passes through it, the resistance, if it is not constant, must depend upon even powers of the intensity of the current through each element of the conductor. Hence if we can cause a current to pass in succession through two conductors of different sections the deviations from Ohm's law will be greater in the conductor of smaller section, and if the resistances of the conductors are equal for small currents they will be no longer equal for large currents.

The first method which occurred to the Committee was to prepare a set of five resistance coils, of such a kind that their resistance could be very accurately measured. Mr Hockin, who has had great experience in measuring resistances, suggested 30 ohms as a convenient magnitude of the resistance to be measured. The five coils, and two others to complete the bridge, were therefore constructed, each of 30 ohms, by Messrs Warden, Muirhead, and Clark, and it was found that a difference of one in four millions in the ratio of the resistances of two such coils could be detected.

According to Ohm's law, the resistance of a system consisting of four equal resistances joined in two series of two, should be equal to that of any one of the coils. The current in the single coil is, however, of double the intensity of the current in any one of the four coils. Hence, if Ohm's law [illegible] and if the five coils when compared in pairs with the same current are found to have equal resistances, the resistance of the four coils combined would no longer be equal to that of a single coil.

A system of mercury cups was arranged so that when the system of five coils was placed with its electrodes in the cups, any one of the coils might be compared with the other four combined two and two.

After this comparison had been made, the system of five coils was moved forward a fifth of a revolution, so as to compare the second coil with a combination of the other four, and so on.

The experiments were [illegible] by Mr G Chrystal, B A, Fellow of Corpus Christi College, who has prepared a report on the experiments and their results.

A very small apparent deviation from Ohm's law was observed, but as this result was not confirmed by the much more searching method of experiment afterwards adopted, it must be regarded as the result of some irregularity in the conducting power of the connections.

The defect of this method of experiment is that it is impossible to pass a current of great intensity through a conductor without heating it so rapidly, that there is no time to make an observation before its resistance has been considerably increased by the rise of temperature.

A second method was therefore adopted in which the resistance was compared by means of strong and weak currents, which were passed alternately through the wire many times in a second. The resistances to be compared were those of a very fine and short wire enclosed in a glass tube, and a long thick wire of nearly the same resistance. When the same current was passed through both wires, its intensity was many times greater in the thin wire than in the thick wire, so that the deviation, if any, from Ohm's law, would be much greater in the thin wire than in the thick one.

Hence if these two wires are combined with two equal large resistances in Wheatstone's Bridge, the condition of equilibrium for the galvanometer will be different for weak currents and for strong ones. But since a strong current heats the fine wire much more than the thick wire, the law of Ohm could not be tested by any ordinary observation, first with a weak current and then with a strong one, for before the galvanometer could give an indication the thin wire would be heated to an unknown extent. In the experiment, therefore, the weak and the strong current were made to alternate thirty and sometimes sixty times in a second, so that the temperature of the wire could not sensibly alter during the interval between one current and the next.

If the galvanometer was [illegible] in equilibrium, then if Ohm's law is true, [illegible] through the galvanometer [illegible] current [illegible]. But if Ohm's law is not true the apparent equilibrium of the galvanometer must arise from a succession of alternate currents through its coil, [illegible] when the strong current is flowing, and in the opposite direction when the weak current is flowing. To ascertain whether this is the case we have only to reverse the direction of the weak current. This will cause the derived currents through the galvanometer coil to flow both in the same direction, and the galvanometer will be deflected if Ohm's law is not true.

Mr Chrystal has drawn up a report of the second experiment, giving an account of the mode in which the various difficulties were surmounted. Currents were employed which were sometimes so powerful as to heat the fine wire to redness, but though the difficulty of obtaining a steady action of the apparatus was much greater with these intense currents, no evidence of a deviation from Ohm's law was obtained, for in every experiment in which the action was steady, the reversal of the weaker current gave no result. The methods of estimating the absolute value of the currents are described in the report.

A third form of experiment, in which an induction coil was employed, is also described, but though this experiment led to some very interesting results the second experiment gives the most searching test of the accuracy of Ohm's law.

Mr Chrystal has put his result in the following form:—If a conductor of iron, platinum or German silver of one square centimetre in section has a resistance of one ohm for infinitely small currents, its resistance when acted on by an electromotive force of one volt (provided its temperature is kept the same) is not altered by so much as the millionth of a millionth part.

It is seldom, if ever, that so searching a test has been applied to a law which was originally established by experiment, and which must still be considered a purely empirical law, as it has not hitherto been deduced from the fundamental principles of dynamics. But the mode in which it has borne this test not only warrants our entire reliance on its accuracy within the limits of ordinary experimental work, but encourages us to believe that the simplicity of an empirical law may sometimes be an argument for its exactness, even when we are not able to show that the law is a consequence of elementary dynamical principles.

Abstract of the Twelfth Report of the Committee for Exploring Kent's Cavern, Devonshire. Read at Glasgow, September 8.—The Eleventh Report, presented by the Committee

to the Association, during the meeting at Bristol in 1875, brought up the narrative of the exploration to the end of July of that year. From that date the work has been carried on uninterruptedly in all respects as in previous years; and it is intended in the present report to describe the researches made during the thirteen months ending Aug. 31 of the present year.

The superintendents have had the pleasure, as in former years, of conducting a large number of persons into the cavern, of explaining to them on the spot the mode of working, and describing the facts which have been discovered, as well as of setting forth their bearing on palæontology and anthropology. The cavern has also been visited by numerous persons, who have been conducted by the "Guide," *i.e.* the foreman of the work, under arrangements laid down by the superintendents.

The Great Oven.—Your Committee stated last year, that on July 27, 1875, they began the exploration of the small passage known as "The Great Oven," which connects with one another "The Cave of Inscriptions" and "The Bear's Den"—the two remotest chambers of the cavern. The Great Oven may be said to consist of three reaches—the eastern, central, and western. The western reach—the only one which has been explored—extends tortuously from its commencement in the south-west corner of the Cave of Inscriptions, for a distance of 58 feet, where it is succeeded by the central reach. At its mouth it is 8 feet high, from the limestone roof to the bottom of the usual 4-feet excavations made by the Committee. Its width is commonly about 4 feet, but at one point it contracts to 3 feet, and at another expands to 7 feet. Throughout its entire length the roof and walls have the aspect of a well-worn water-course.

There was no continuous floor of stalagmite, though here and there portions of such a floor, perhaps never continuous, adhered to and projected from the walls; and pieces of stalagmite, as well as detached "paps" of the same material occurred in the deposit below. There was no reason to suppose that earlier explorers had ever worked in this branch of the cavern.

The deposits were a thin layer of "cave-earth," lying immediately on "breccia," without any intermediate crystalline stalagmite such as occurs in typical sections. At the entrance, and up to 34 feet from it, the usual 4-feet sections failed to reach the bottom of the breccia, so that its depth is undetermined; but at the point just mentioned, the limestone floor was found at a depth of 3·5 feet below the upper surface of the cave-earth, and thence to the inner end of the reach the floor was found everywhere at a depth of from 2 to 4 feet, thus displaying a continuous limestone floor for a length of 24 feet, and giving a pretty uniform height of 8·5 feet to this portion of the reach. The upper surface of the cave-earth ascended from the mouth to the inner end of the reach, at a mean gradient of about 1 in 7, whilst the limestone floor was inclined in the same direction at a somewhat higher gradient.

The total number of "finds" in this part of the Great Oven was 50. The remains yielded by the cave-earth included 2 teeth of hyæna, 6 of bear, 10 of ox, 1 plate of a small molar of mammoth, several bones and pieces of bone, including an astragalous of horse, a few coprolites of hyæna, a portion of a flint flake, and a flint chip.

The flake (No. 6672) is of a pretty uniform cream colour, almost a parallelogram in outline, 1·4 inch long, ·7 inch broad, abruptly truncated at each end—one of which retains the original surface of the nodule from which it was struck—and ·3 inches in greatest thickness. The inner surface is slightly concave, whilst the outer is very convex, and consists of three planes or facets, the central one commencing near the but end, whilst those on each side of it extend the entire length of the flake. Its ridges, and, excepting a very few small notches, its lateral edges are quite sharp, and show that it can have had little or no wear and tear in any way, and that in all probability it reached the spot in which it was found, not by the transporting action of water, but by human agency. It was met with less than a foot below the surface of the cave-earth, 40 feet from the mouth of the Great Oven, on Oct. 13.

The specimens yielded by the breccia were ten teeth of bear and a few bones, none of which call for special description.

The exploration of the western reach of the Great Oven was completed on October 27, 1875, three months having been spent on it.

The Labyrinth.—The existence of the chamber termed "The Labyrinth" was probably known to but few persons when Mr. MacEnery commenced his researches in the cavern in 1825, as what appeared to be its *two* entrances must have then been so nearly filled as to reduce them to the size of mere pigeon-holes. These entrances are respectively about 100 and 200 feet from the mouth of what is called "The Long Arcade," from which the nearest external entrance of the cavern is about ninety feet farther. The name of *Labyrinth* was given to the branch of the cavern now under notice on account of the difficulty which, without a guide, visitors experienced in threading their way between the numerous masses of fallen limestone and the large bosses of stalagmite which occupied its floor. "There was," says Mr. MacEnery, "a tradition of the loss of life here by a young man who ventured to explore it without a guide. It is certain that two gentlemen, who lost their light and way, spent a night of horror here. Dreading to advance for fear of falling into the pits, they remained immovable until their friends came to their relief."[1]

The Labyrinth extends from the Long Arcade, in a south-easterly direction, for about forty-six feet, throwing off three narrow branches at and near its inner end. Of these the central one, opening out of the south-eastern corner, and which it is proposed to call "Matthews's Passage," after one of the workmen, leads into The Bear's Den.

The walls and roof of the Labyrinth, though by no means without traces of the erosive action of flowing water, are in most places extremely rugged, and suggest, by their fretted aspect, that even the last of the numerous blocks of limestone encumbering the floor must have fallen a long time ago.

It is separated from the Long Arcade by a massive curtain of limestone depending from the roof to the depth of nine feet, across a space about eighteen feet wide, being, so to speak, slightly looped up at each end to form two small entrances.

Mr. MacEnery had conducted some diggings in the Labyrinth, and had carried them to a depth of at least three feet at one of the entrances, so that, by assuming a stooping posture, ingress and egress became possible. In all other parts of the chamber his work was much less deep.

Omitting the large blocks of limestone, the deposits were:—

First, or uppermost, a floor of granular stalagmite, from which arose several large bosses also of stalagmite, one of which was eleven feet high above the floor, whilst its base occupied a circular space fully fifteen feet in mean diameter.

Second, a layer of cave-earth, rarely amounting to more than a foot in depth, and sometimes to not more than a few inches, whilst it occasionally reached as much as two feet.

Third, though it may be doubted whether there was a floor of the more ancient, the crystalline, stalagmite in the Labyrinth, the lower, and by far the greater part of the bosses mentioned above was of that variety, and was covered with a comparatively thin envelope of the granular kind, without any mechanical deposit between them.

Fourth, the breccia, or, so far as is known, the most ancient deposit in the cavern, lay immediately beneath the cave-earth, from which there was nothing to separate it, and extended to a depth exceeding that to which the excavations were carried.

In order to achieve the thorough exploration of the Labyrinth, it was necessary to break up all the bosses of stalagmite, with the exception of the largest of them, of which a portion has been left intact, it being believed that it shows strikingly the utter inadequacy of the data derived from a *boss* to solve the problem of the amount of time represented by a *floor*, and *vice versâ*.

The upper surface of the cave-earth rose from the mouth of the Labyrinth to its innermost extremity at a mean gradient of about 1 in 17.

The total number of "finds" in this branch of the cavern was 135, and the specimens they included were as follow:—

Lying on the Surface.—Three portions of ribs and two other bones, the two latter having been cut with a sharp tool, perhaps by an existing butcher, and one bone of bat.

In the Granular Stalagmite.—1 tooth of lion.

In the Cave-earth.—32 teeth of hyæna, 7 of bear, 6 of fox, 3 of horse, 2 of rhinoceros, 3 plates of a molar of a young mammoth, 1 of lion, 1 of ox, and 1 of sheep (of doubtful position); several bones and portions of bone, including a tarsus of bird, and two pieces of bone apparently charred; 1 coprolite, and 1 small chip of flint.

In the Crystalline Stalagmite.—6 teeth of bear, of which 5 were in one and the same jaw.

In the Breccia.—215 teeth of bear, and a considerable number of bones, of which many are good specimens.

The exploration of the Labyrinth was commenced on October

[1] See "*Trans.* Devon. Assoc.," vol. iii., p. 238.

28, 1875, and completed on July 10, 1876, upwards of eight months having been spent on it

Matthews' Passage.—Having finished their researches in the Labyrinth, the Committee proceeded at once to explore the small branch leading from it to the Bear's Den, and termed, as already stated, Matthews's Passage, thus leaving the two other and adjacent small ramifications to be undertaken on some future occasion. To this course they were tempted mainly by the wealth of osseous remains which, from Mr MacEnery's description, they are likely to find in the Bear's Den

Matthews's Passage consists of two reaches. The first extends for about 14 feet towards the south-east, where the second turns sharply toward east north-east, and, after a somewhat tortuous course of about 15 feet, enters the Bear's Den. Their height is from 9 to 10 feet almost everywhere, measuring, as usual, from the bottom of the excavation, which nowhere reaches the limestone floor, and they vary from 3.5 to 7 feet in width. The walls and roof, the latter especially, bear evident traces of the erosive action of a flowing stream, succeeded by the corrosion due, no doubt, to acidulated water, as the surfaces are much fretted.

There were but scanty traces of a stalagmitic floor in the first reach, in which, however, the earlier explorers had here and there broken ground, but throughout the entire length of the second reach a floor extended from wall to wall, varying from 10 to 24 inches in thickness.

The mechanical deposits in the first reach were the usual thin layer of cave earth above, and the breccia of unknown depth below, but in the second reach the space beneath the stalagmite floor was mainly occupied with large loose masses of limestone, some of which required to be blasted more than once in order to remove them. The spaces between them were filled with cave earth or breccia with comparatively few specimens of any kind.

The upper surface of the cave earth was almost perfectly horizontal in the first reach, but in the second it rose towards the Bear's Den at a gradient of about 1 in 7.

Matthews's Passage yielded a total of 439 "finds," including specimens which may be thus distributed:

In the Cave-earth: 26 teeth of hyæna, 2 of bear, 1 of an immature mammoth, 1 of fox, and a considerable number of bones, many of them being broken and a few of them gnawed.

In the Breccia: 100 teeth of bear, and a large number of bones. The richest "finds" were met with in a small recess at the junction of the two reaches, where the teeth and bones were huddled confusedly together, suggesting that a rush of water had probably carried them to the spot they occupied.

No trace of man was detected in any part of the Passage, the exploration of which was completed on August 31, 1876, having occupied about seven weeks.

In looking over the work accomplished since the Eleventh Report was presented in 1875, the following noteworthy facts present themselves:—

1. In their Eleventh Report, the Committee sketched the distribution, in the cavern, of the remains of the mammals which characterise the cave earth. Of this sketch, the following is a brief summary:—The hyæna had been met with wherever the cave earth was found; the hare had not been detected anywhere in the western division of the cavern—that most remote from the external entrances; the badger, wolf, and ox had not been found beyond "The Charcoal Cave," and relics of horse, rhinoceros, deer, fox, elephant, and lion had not appeared beyond "The Long Arcade."

It is now necessary to say that remains of ox, horse, rhinoceros, fox, elephant, and lion have all been found *beyond* the Long Arcade, in one or more of the three branches of the cavern explored since the Bristol meeting. In all other particulars the distribution remains at present as sketched in 1875.

2. No tooth, or, so far as is at present known, other trace of [illegible] been met with since the last Report was drawn. In short, the only evidence of the presence of this mammal which the Committee have detected during the continuous labour of almost twelve years, is the solitary incisor found July 29, 1872, a fact well calculated to impress one with the unsatisfactory nature of merely negative evidence. It cannot be doubted that had this comparatively small specimen been overlooked, those palæontologists who were sceptical respecting the occurrence of Machairodus in Kent's Hole, would have believed their scepticism to be strongly confirmed by the labours of the Committee, whilst the number of sceptics would have been greatly increased.

3. As already stated, the Committee spent upwards of ten consecutive months, in 1875-76, in exploring the Labyrinth and Matthews's Passage; yet, during all this time, and in these two important branches of the cavern, they found no trace whatever of prehistoric man. Had they, on receiving their appointment from the British Association in 1864, commenced their researches in either of the branches just named—and such a course was by no means without its advocates—instead of beginning at the external mouth of the cavern and proceeding thence steadily through the successive chambers and galleries, there can be little or no doubt that Kent's Hole would have been pronounced utterly destitute of any evidence on the question of human antiquity, and but poorly furnished with remains of extinct mammalia. The work would probably have been closed without going further, to the great loss of anthropology and palæontology, as well as of popular education in these important branches of science.

Sixth Report on Earthquakes in Scotland, by Dr James Bryce, F.G.S.—The past year was a period of comparative quiescence in Scotland. Dr Bryce described the arrangements made for recording future shocks in the Comrie district. The Committee recommended the erection of seismometers at Ardoch, Dunblane, and Bridge of Allan, where very distinct disturbances were felt in 1875.

Second Report of the Committee on the Circulation of Underground Waters in the New Red Sandstone and Permian Formations of England, by C. E. de Rance, F.G.S.—The Committee's inquiries have been continued this year, particularly with reference to Liverpool, Birkenhead, Nottingham, and Birmingham. Information has also been promised from Staffordshire. The Committee hope to complete their labours before next meeting of the Association.

Statistics were given by Mr de Rance regarding the amount of water obtained from wells at Liverpool, Coventry, Birmingham, Leamington, Nottingham, Birkenhead, Warrington, and Southport. It was mentioned that at Liverpool the level of the water in the public wells is gradually being lowered.

At Barrow-in-Furness a bore-hole, 210 feet deep, found, at the depth of 250 feet, a spring which now yields 1,500 gallons daily, and rises 12 feet above the surface. In this case, as had been predicted by Mr Aveline, a member of the Committee, the Permian rocks were found directly overlying the Millstone Grit, and it was thus proved that the Coal Measures lying to the north are not continuous beneath the Permian. Another important circumstance discovered by this boring was the existence of petroleum in the Millstone Grit.

The New Red Sandstone being porous and ferruginous, has been found to filter the water and oxidise the organic matter contained in it. Water from wells in the New Red, even when not artificially filtered, ranks high among drinking waters for purity and wholesomeness, containing little saline and hardly any organic matter.

Taking an average rainfall of 30 inches per annum, and granting that only 10 inches percolate into the rock, the supply of water stored up by the Permian and New Red formations was estimated by the Committee to amount to 140,800,000 gallons per square mile. This rate would give, for the 10,000 square miles covered by the formations, 1,408,000,000,000 gallons. Only a very small proportion of this amount is made available for the supply of cities and towns.

Report on Tree-Rings and [illegible], by Mr. W. S. Mitchell.

SECTION B.—CHEMICAL SCIENCE

In Section B the amount of work done during the meeting was very considerable, and the quality of the work was fairly good. On Thursday a considerable number of members attended to listen to the president's address, which has been already reported. The papers read on that day were not of any great interest.

Mr Pattison Muir gave an account of some preliminary investigations upon *Essential Oil of* [illegible]. Mr A. R. Newlands read a paper calling attention to various relations which exist among the atomic weights of the Elements. The greater part of the matter contained in this paper has been, at various times, already made public by Mr Newlands. In a paper by Mr J. J. Coleman upon *A New Continuous Machine for the Liquefaction of Gases by combined Cold and Pressure*, attention was drawn to certain dynamical questions relating to the best method of obtaining cold from compressed gas so as to utilise the cold produced

in expansion. Mr. Coleman's paper could not well be understood without the sketch which accompanied it. A lengthy paper by Mr. W. Ramsay followed, upon *Picoline.* The author described many new salts of picoline, especially those formed by the action of the halogens, which he showed might be classed as—

1. Picoline + 2 atoms of halogen.
2. Picoline + 1 molecule of haloid acid.
3. Picoline + 1 molecule of haloid acid + 2 atoms of halogen.

By the action of chlorine on picoline an oily body may be also produced, from which, by the addition of water, a solid is obtained, which is probably a hypochlorite derivative. Various other salts of picoline were described. The author thought that discussions concerning the constitutional formula of picoline were as yet premature; his investigations, however, appear to show that this base is not a nitrile nor carbamine, and that it does not contain the methyl group. On oxidation it yie[illegible] pyridine dicarbonic acid.

[illegible] last paper read was by Mr. J. Stoddard, *On the Zinc Desilverising Process.* It was of purely technical interest.

On Friday the Section had its hands full of sewage, the result, as might have been anticipated, being unsatisfactory. The papers read on the sewage question were:—*Report of Committee; Experimental Researches on the Chemical Treatment of Town Excreta*, by Mr. J. Coleman; and *Sewage Purification and Utilisation*, by Mr. J. Banks. The committee's report was confined to operations conducted at Romford Farm on irrigation. During the time of experiment it appeared that the nitrogen retained by the crops amounted to 30·34 per cent. of that received in the sewage; the yield of rye grass was good. The committee did not ask meanwhile to be reappointed. Mr. Coleman advocated the use of charcoal, large quantities of which might be obtained in the form of the residue removed from the retorts in the distillation of shale oil. Mr Banks recommended filtration through large beds of wood or peat charcoal, placed in wire cages, with subsequent aeration by exposing the sewage in the form of a thin cascade, to the action of the atmosphere. In the discussion it was admitted that the operations at Romford were carried on at a loss; Mr. Allen congratulated the advocates of irrigation on their acknowledgment of this fact, saying that the sooner they got rid of the idea of making this matter pay, the better. Dr. Fergus traced all the woes of humanity to the water system now in vogue in large towns; Mr. Spence believed in precipitation, while Dr. Gilbert manfully upheld irrigation and filtration.

As usual, when dealing with sewage, everyone held by his own opinion, and no two people agreed as to what was to be done.

In Mr. Allen's report of the work of the committee appointed to investigate the accuracy of the various methods adopted for analysing "Commercial Phosphates and Potash Salts," the latter part of the problem was alone dealt with. The committee approved of Tatlock's method somewhat modified; that is, they thought that soda salts are best removed by washing with a strong solution of platinic chloride, followed by washing with alcohol; but they recommended that in the presence of much sulphates, the method should be modified by getting rid of the greater part of such sulphates by means of barium chloride before adding platinic chloride. Mr. Allen, who read the report, personally did not approve of the plan of adding sodium chloride in order to convert the potassium sulphate into chloride, because in the presence of large quantities of soda salts he always found the results come out rather low; washing with platinic chloride appearing under these circumstances to remove, along with the soda salts, a portion of potassium salt likewise.

In a short paper *On the Physiological Action of Pyro- Meta- and Ortho-Phosphoric Acids*, Dr. Gamgee, F.R.S., showed that while the ortho acid is physiologically inert, the pyro acid is very poisonous, and the meta acid is intermediate in its action.

A paper by Mr. F. H. T. Allan, *On a Safe and Rapid Evaporating Pan*, concluded the day's proceedings.

On Monday morning the Section was summoned to hear Prof. Thorpe's *Report on the Specific Volumes of Liquids*, but owing to the absence of the author the paper was taken as read.

The

continuation of their labours.

A number of papers were then read. Dr. Emerson Reynolds described experiments on the specific heat of beryllium, which went to prove that the atomic weight of that metal is 9·2; the atomic heat deduced from Dr. Reynolds's experiments being, on this assumption, equal to 5·91. Incidentally Dr. Reynolds showed that the modification of Bunsen's calorimeter used by him might be employed in class experiments, and the accuracy of the law of Dulong and Petit in certain instances thereby demonstrated to students.

Mr. Johnstone Stoney, F.R.S., amused and interested the Section by a number of drawings of tetrahedra, octahedra, &c., on to which he dexterously stuck representations of oxygen atoms, chlorine atoms, and so on. His general endeavour seemed to be to convince his auditors that in most basic salts oxygen is divalent, being in direct combination with the acidifying constituent of the molecule, but that when oxygen is not so directly related to this constituent in basic salts, it is tetravalent.

Dr. Macvicar, of Moffat, brought forward some of his peculiar views as to the constitution of matter, in a paper entitled *On the Possible Genesis of the Chemical Elements out of a Homogeneous Cosmic Gas or Common Vapour of Matter.*

Mr. E. H. Biggs described a new form of voltaic battery. The positive pole consists of a perforated carbon plate, which divides the jar into two divisions; the perforations are closed by means of earthenware plugs. The negative pole consists of a zinc plate. Dilute sulphuric acid is poured into the zinc compartment, and a good oxidising agent into the other. The current is intense, and the result a good constant battery.

The president described a few new derivations of anthracene, remarkable for their instability. Mr. J. T. Brown communicated a note *On Anthracene testing.*

A modification of the sodium sulphide process for the manufacture of soda ash was described by Mr. W. Weldon, under the title of *A Means of Suppressing Alkali Waste.* The sodic sulphate and carbonaceous matter are separately heated, and then brought into contact in a furnace lined with carbon. The sulphuretted hydrogen evolved in the conversion of the sodic sulphide into carbonate is conducted into water containing very finely divided oxide of iron or of manganese; the metallic sulphide so produced is subjected to the action of air, whereby sulphur is thrown down; fresh quantities of sulphuretted hydrogen are then passed in, aeration is again carried out, and so on until about 85 per cent. of sulphur to 15 per cent. of metallic oxide is present. This mixture is dried, and used in the manufacture of sulphuric acid.

Dr. C. R. A. Wright gave a description of some new derivatives of cotarnine, and Mr. Kingzett described briefly his later researches on the *Oxidation of Terpenes*: he stated that the liquid obtained by the oxidation of turpentine was possessed of marked antiseptic properties, which were to be traced to the presence of camphoric acid and peroxide of hydrogen in the liquid.

So many papers relating to technical chemistry were brought forward on Tuesday that it was thought better to sub-divide the Section, allotting the more purely scientific subjects to a sub-section. In this sub-section Dr. Letts described experiments which gave some countenance to the idea that a hydrocarbon having the formula $C_{10}H_{17}$ really existed. His experiments, were not, however, of so exact a nature as to carry conviction to the minds of many of the members. Mr. J. Buchanan described a modified hydrometer used on board the *Challenger*, and also an instrument for registering pressure and temperature at considerable depths.

Papers were read by Dr. Gladstone *On the Copper Zinc Couple*, and by Mr. W. N. Hartley *On Liquid Carbonic Acid in Minerals.*

Mr. R. Da Silva described the general action of hydriodic acid on mixed ethers, having the formula $C_nH_{2n+1}OCH_3$, and Dr. Cameron called attention to "Ammonic Selenio-cyanide." Of those papers which dealt with applied chemistry, the most interesting was one by Mr. J. A. R. Newlands, in which he described the *Alum Process in Sugar Refining.* The object of this process is to remove potash salts by the addition of ammonium sulphate in quantity sufficient to form alum, which is precipitated. The residual acid liquors are neutralised by means of lime. The other technical papers were chiefly occupied with sketches of the various chemical industries of Glasgow and the neighbourhood. Mr. F. Ward described a method for preparing the paper used for cheques, which prevents fraudulent alterations being made in the writing of the cheques.

On Wednesday morning the section met for a short time, when Mr. Pattison Muir read two papers *On Bismuth Compounds*, and *On the Action of Dilute Saline Solution upon Lead.*—Prof. Dewar described some experiments by which he has been able

to transform chinoline into aniline. Chinoline, or more probably a mixture of the two bases, C_9H_7N, and $C_{10}H_9N$ yields, on oxidation, a new acid having the formula $C_7H_5NO_4$, which treated with potash lime this acid yields aniline and ammonia only. The author of the paper thought that probably two intermediate bodies are formed, the latter of which has the same formula as indol. Prof. Dewar hopes to separate this body. This investigation shows that the bases of the pyridene series are related to the aromatic nucleus of the benzene series.

Dr. Tilden described his investigation on the *Nitroso-Ind... tives of the Terpenes*. So far as his experiments have gone, he has found but two different nitroso compounds having the formula $C_{10}H_{15}NO$—one of these melts at 70°, and the other at 129°. Dr. Tilden also described a substance isomeric with purpurin, $C_{14}H_8O$, produced by the action of chromic acid upon either of the aloms. Mr. Dittmar made some remarks on Reboul's paper on pyrotartaric acid, and also described at some length experiments on the analysis of coal gas. He did not consider that the ultimate analysis of coal gas gave any reliable information as to its illuminating power. He showed that benzene vapour may exist in coal gas, but that by passage into an ordinary gas holder the greater part of that vapour is removed by the water in the gas holder. A few other papers were read relating to technical chemistry.

Altogether the section may be congratulated on having got through a fair amount of honest work.

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SECTION C. GEOLOGY.

Notes of Terraces, Haughs, and Haughs at ... in the Carron Valley ... Falkirk, by Dr. D. Milne Home, F.G.S. In the region in question the author said there was highest of all, and first in point of date, a terrace of gravel 150 feet above the present sea level. The formation of this platform was due to the arranging action of water, and probably of the sea. Near its edge it is much denuded, and cut into by streams, the fragments now remaining having been sometimes pared down by the action of rivers on either side into sinuous and hackled mounds which in form and structure are exactly what are known as Kaims or Eskers.

Below this level and skirting the rivers, especially the Carron and Bonny, near their confluence, are two distinct sets of haughs or alluvial flats, the one set, covered by ordinary floods and standing about ten feet above the present level of the stream; the other and older set standing 35 feet above the sea level, and formed by the rivers, while the latter ran at a higher level than that of their present channel, a level which the author judged might be about 25 feet, allowing 10 feet for the ordinary height of floods then as now. At this period the author maintained, the streams had not begun to cut down to their present levels, as they in all probability debouched on a sea which is now represented by the well known "Twenty-five foot raised beach."

On the Earthquake Districts of Scotland, by Dr. James Bryce, F.G.S.—Dr. Bryce observed that there are two lines along which earthquakes are commonly observed, the one running from Inverness through the North of Ireland, to Galway Bay, and the other passing east and west through Comrie. The phenomena of earthquakes in the latter district are now being systematically observed and recorded, under the direction of a committee appointed by the British Association, seismometers being employed on the two principles of vertical pendulums and delicately poised cylinders. Arrangements have been made to ascertain whether shocks in this region can be traced to any common central point, there being reason to believe them to be connected with a mass of granite in Glen Lednoch, whose position was indicated on a map exhibited by the author.

The existence in the vicinity of Comrie of important lines of fracture in the earth's crust was pointed out, and it was suggested that these might be records of earthquakes in remote geological times. One of these lines of fracture is filled up with a dyke of basaltic rock, traceable from the Melville Monument, near Comrie, to Loch Lubnaig, and belonging to the series of dykes now regarded as of Miocene age. The other line of fracture is much older, and divides (with an enormous displacement) the Lower Old Red formation from the Metamorphic rocks of the highlands.

For the Comrie earthquakes, Dr. Bryce was inclined to accept Mr. Mallet's explanation, viz., the shock produced by the fall of masses of rock from the roof of some subterranean cavity.

As a remarkable manifestation of earthquake activity, Dr. Bryce alluded to a sudden rise of 2½ feet in the level of Loch Earn, described in a former report of the Earthquake Committee. On that occasion no change in the atmospheric pressure was indicated by the barometer. It was several hours before the motion of the lake's surface, produced by the shock, subsided.

On the Parallel Roads of Glen Roy, by Dr. D. Milne Home, F.G.S. Dr. Milne Home exhibited a map showing the parallel roads as laid down by the Ordnance Survey, and the positions of the barriers necessary for the damming up of the lake at the successive stages marked by the several beaches or "roads." The author rejected the theory of a marine origin for the beaches, and declared himself unable to accept Prof. Tyndall's view that the lakes were barred by glaciers protruding from lateral valleys.

He then went on to show that solid barriers not of ice, but of detritus, would alone account for the phenomena in question. The cutting through of the barriers would account for the different levels of the roads. The author pointed out that in the positions where the detrital barriers must have stood the roads stop short abruptly.

It was pointed out on the map that the detrital mounds in Glen Spean make a horse-shoe bend with the convexity up the valley. They could not therefore have been derived from a glacier coming down Glen Spean, or from the lateral valley of Loch Treig. Mr. Milne Home ascribed them to the droppings of icebergs floating eastward up the valley.

Mr. J. Macintosh also read a paper *On the Parallel Roads of Glen Roy*, supporting the marine theory of their origin.

On the Geology of Fair Isle, Shetlands, by G. A. Gibson, M.D., F.S.C. The author had constructed from his own observations a geological map of the island, which was exhibited on the wall. A fault running north and south divides Foula into two regions of very different aspect. On the eastern or upthrow side of the fault the rock is a foliated gneiss much folded and faulted and copiously veined with red granite and to a less extent with grey granite. There is no granite mass *in situ* in the neighbourhood whence the veins may be supposed to have radiated. The ... in character and in its general strike the Laurentian of the north west of Scotland.

On the western side of the fault the rocks are flags and sandstones identical with the Lower Old Red beds of the Shetland Islands, although in Foula no fossils have been detected in them. They dip at first at a high angle away from the fault, but gradually become flatter westwards, till they are almost horizontal at the sea. Their thickness is estimated by Mr. Gibson at 6,000 feet.

The granite dykes do not traverse the Old Red rocks.

On the Junction of Granite and Old Red Sandstone in Arran, by E. Wunsch, F.G.S. The author described and illustrated, by diagrams, sections at ... and Corrie, exhibiting a passage from Old Red flags and Conglomerates to the granite of the central nucleus of the island. This fact, the author said, would necessitate the alteration at the points in question, of Dr. Bryce's and ... maps, which agreed in representing the granitic nucleus as surrounded by a ring of slates, there being no slates at least as far south as Moulton. He mentioned that everywhere at the point of contact with the Old Red Sandstone the granite was delicately ... or clouded, as though the black film of the also ... mass had remained floating and become fixed in the white pasty mass, and this appearance, he held, was in itself sufficient to point to a junction of granite with rock other than slate, for though innumerable instances might be seen in other parts of the island of junctions of granite with true slate, in not a single instance was the adjoining granite affected in this particular manner.

A suite of rock specimens was exhibited showing the passage of the sedimentary rocks into granite.

On the most recent Researches in the Structure and Affinities of the Plants of the Coal Measures, by Prof. W. C. Williamson, F.R.S.—Prof. Williamson expressed his strong conviction that the flora of the Coal Measures would ultimately become the battle field on which the question of evolution with reference to the origin of species would be fought out. There would probably never be found another unbroken period of a duration equal to that of the Coal Measures. Further, the roots, seeds, and whole reproductive structure of the Coal measure plants are all present in an unequalled state of preservation. With reference to Calamites, Prof. Williamson said that what had formerly been regarded as such had turned out to be only casts in sand and mud of the pith of the true plant.

Brongniart believed, forty years ago, that he had established two types of the plant called calamite, one like our modern equisetums, and the other (Calamodendron) allied to the pines. Prof. Williamson, in the first of his memoirs, announced that this was an error, that there was only one generic type representing the modern equisetaceous plants, but gigantic. He had recently obtained a specimen of a calamite with the bark on, exhibiting the following structure:—

A nucleal cellular pith, surrounded by canals running lengthwise down the stem; outside of these canals wedges of true vascular structure; and lastly, a cellular bark.

Brongniart had further separated Lepidodendron from Sigillaria, being under the impression that a layer of exogenous growth characterises Sigillaria and is absent in Lepidodendron. But Prof. Williamson had obtained a series of young and old specimens which clearly showed that the difference is not generic, but is merely one of species, or of the age of individual plants.

Prof. Williamson also explained that the separation of the genera Asterophyllites and Sphenophyllum was uncalled for, the wedge-shaped leaf of Sphenophyllum being merely the result of the coalescence of several of the leaves of Asterophyllites.

On Labyrinthodont Remains from the Upper Carboniferous (Gas Coal) of Bohemia, by Dr. Anton Fritsch.—The gas coals of Bohemia are unusually rich in remains of Labyrinthodonts, fishes, and insects. They lie near the top of the Coal Measures, and are regarded by Dr. Fritsch as passage-beds, the fauna being of Permian and the plants of Carboniferous types.

Dr. Fritsch exhibited a series of plates, as well as his original specimens. In one Labyrinthodont the skeleton is completely ossified. A Ctenodus has the bony part of the skull preserved. A Diplodus has a perfect lower jaw, with teeth.

Among insects, one new species has the seventh pair of feet enlarged as in Pterygotus.

A new species, named by Dr. Fritsch *Ulus constans*, is interesting as showing how little the genus has changed since Palæozoic times.

On the Strata and Fossils between the Borrowdale Series and the Coniston Flags of the North of England, by Prof. Harkness, F.R.S., and Prof. A. H. Nicholson, M.D.—The authors had found an unbroken succession of the strata on this horizon at several places in the North of England, which, as exhibited in Skelgill, they tabulated as follows:—

Base of Coniston flags, with *Monograptus*, *Retiolites Geinitzii*, &c.
Knock beds, "pale slates," with casts of a small *orthis*.
Graptolitic mudstones with a grey band full of brachiopods, &c.
Coniston limestone and shale—the shale highly fossiliferous.
Traps, the summit of Borrowdale Group, with ash beds containing rust cavities ("Stylend grassing beds").

These deposits must be for the most part Lower Silurian. Below them are the Skiddaw slates, containing well-marked graptolites. The Skiddaw slates are found neither in Scotland nor Ireland.

The Tarranon shales, which are 300 feet thick in South Wales, develop in the North to a thickness of 1,500 feet, and the Geological Survey has mapped them as conformable to the Bala beds.

South of Bala Lake, Lower Llandovery rocks get in between the Tarranon shales and the underlying Bala beds. Still further to the south the Upper Llandovery comes in.

The authors conclude, therefore, that the Tarranon shales of the North represent also the Upper and Lower Llandovery rocks. They consider also that the Lower Llandeilo of the Southern Uplands of Scotland, estimated by the Geological Survey to have a thickness of 20,000 feet, is represented in the North of England by contemporaneous igneous rocks.

Notes on the Drifts and Boulders of the Upper Part of the Valley of the Wharfe, Yorkshire, by the Rev. E. Sewell, M.A., F.G.S.—In this region there are two boulder clays, the lower blue and hard, with many glaciated stones, and the upper, and more generally diffused, yellow and looser, and with comparatively few glaciated stones. In the blue clay there are many boulders from the north-west, while those of the yellow clay are for the most part of the local Millstone Grit.

In the upper part of the valley the clays are largely concealed by gravel and sand, which attain a thickness of 150 feet. This deposit appears to graduate into, and alternate with, the underlying yellow boulder-clay. It rises here and there into eskar-mounds. It contains pebbles and boulders mostly of the local Millstone Grit, but there are also some of Carboniferous Limestone.

The Valley of the Wharfe must have been filled up with gravelly drift to a certain height, and then (in post-glacial times) must have commenced the excavation of the present valley.

The author thinks that the theory of a marine origin for the gravel best accounts for the phenomena it presents. The boulders may have been dropped from floating ice.

Above the valley, on the hills of Millstone Grit, there occur boulders of limestone which must have come from the north-west, crossing intervening valleys and ridges. The boulders reach the height of 1,200 feet. There are no erratics on the eastern side of the Pennine Hills above 1,250 feet, but on the western slope they occur at greater heights.

On Ridgy Structure in Coal, with Suggestions towards accounting for its Origin, by Prof. James Thomson, F.R.S.E.—The coal in question was exhibited by the author, and was derived from South Wales. It presented the appearance in miniature of a number of sharp, serrated, labyrinthine mountain ridges. Prof. Thomson suggested that the coal-seam might have diminished in weight owing to the escape of fire-damp, and that thereupon the pressure of the overlying strata might have reduced its bulk, a double series of oblique fissures allowing the upper half of the seam to interlock with the lower half. Experiments on the behaviour of cast-iron columns under pressure had demonstrated the possibility of such fissures.

Further Illustration of the Jointed Prismatic Structure in Basalts and other Igneous Rocks, by Prof. James Thomson, F.R.S.E. Prof. Thomson suggested that the structure in question might have been induced by the accidental presence of foreign substances in the molten rock. The paper was illustrated by specimens of ochreous clay, and of bricks and fire-clay used in melting gold in the Royal Mint.

SECTION D.—BIOLOGY.

After the delivery of the President's Address, Dr. Hooker, in proposing a vote of thanks to him, said that the President should not have termed his address an excursion into the bye-paths of biology, but rather a discovery and exposition of the true value of many small facts hitherto considered trivial. Mr. Darwin and Mr. Wallace were the men who were utilising the "waste observations of biology." He entirely agreed with Mr. Wallace as to the great importance of animal life to the colouration of flowers, but perhaps a broader aspect still was to be thought of in that connection—the influence of climate, the chemical rays of the sun, and cloudy weather. Thus brightly-coloured flowers were much more numerous in the eastern than in the western districts of Great Britain. Again, the further islands were from great continents, the less conspicuous colouration was possessed by their flowers, as a rule.

Department of Anthropology.

Several papers were read bearing upon the Highland race and language. Mr. Hector McLean was of opinion that there was not sufficient basis for the view that the primitive continental Celts were divided into two branches, Gaelic and Cymric. It was perhaps more reasonable to consider the ancient Celtic language as possessing several dialects, varying gradually from the Baltic to the Mediterranean and from the Alps to the West of Ireland. Mr. McLean thought there was a tendency to consider the Celtic languages more Aryan than they really were, and he gave a list of words from non-Aryan languages having a close resemblance in form to Celtic words. The Gaelic language now fringed the whole west of the British Isles, with considerable though gradual dialectical differences. South Kintyre was nearer in language to Antrim than to Skye. He believed that Kerry men and Sutherlanders would not require long intercourse in order to be able to understand each other. Mr. McLean also noticed a number of the physical characteristics of the Western Highlanders, from which he inferred that they had been materially influenced as a race by the Norwegian occupation from the eighth to the thirteenth century. He had looked at Danish, Swedish, and Norwegian sailors side by side with Western Highlanders, and had been surprised at the resemblances between the former and the fair individuals of the latter. Local names of Norse origin were found in all the isles and all along the coast line. His general conclusions were that the Highlanders of the present day were derived from a commixture of several races, pre-Celtic, Celtic, and Scandinavian, and it

would seem that there must have been three or four pre-Celtic stocks. Another paper by Mr [illegible] was *On the Anglicising and Gaelicising of Surnames*.

Dr Pirie read a paper *On Recent Remains of Totemism in Scotland*. He defined Totemism as a form of idolatry; a totem was either a living creature or a representation of one, mostly an animal, very seldom a man. It was considered, from reference to Pictish and other devices, that a dragon was a favourite representative among such people of Britain as had not been brought under Roman sway.

Mr W. J. Knowles, of Belfast, gave a further account of the prehistoric discoveries made at Port Stewart, near Londonderry. They were found in pits excavated by the wind among the sand hills. The remains included arrow heads, scrapers, hammer flakes, bone implements, and bones of the horse, ox, pig, dog, &c., together with edible shells, all mixed up together, and apparently of the same age. As late as the 20th of July last the author and two companions had found, in less than four hours, three arrow heads, two beads, thirty or forty scrapers, and several hammer stones, as well as bones which bore mark of cutting or sawing. One of the most interesting of recent finds was about a dozen very small stone beads, found within a few yards' radius. They were concave on one side and convex on the other. Mr Knowles had tested the cutting power of the flint implements on a common beef bone, using a little water, and he found that he cut through into the hollow of the bone in fourteen minutes; he had also [illegible] a hole through a bone with a piece of flint. The marks made by the flints on recent bones were very similar to those found on the ancient bones. Mr Knowles also read a paper *On the Classification of Arrow-heads*, recommending the use of the following terms:—stemmed, indented, triangular, leaf-shaped, [illegible]-shaped, and lozenge-shaped. Commander Cameron mentioned that arrows of the same shape as many exhibited by Mr Knowles were [illegible] in various African tribes. One shape was [illegible] to carry the arrow to a [illegible], and was principally used [illegible] at long distance. The shape of the arrow varied according to the taste of the makers; in one district there were forty or fifty different shapes.

Commander Cameron read part of a paper by Capt. J. S. Hay, relative to a strange malformation among people in the district of Akem, West Africa, the information of which was received with some incredulity. The malformation in question is confined to the male sex, and consists in a protuberance or enlargement of the cheek bones under the eye, taking the form of horns on each side of the nose. The malformation begins in childhood, but does not appear to be hereditary. It presents no resemblance to a diseased structure, nor is it a raised cicatrix. An endeavour is being made to procure skulls in which the phenomenon appears, for exhibition to scientific men in London.

Miss A. W. Buckland's paper *On Primitive Agriculture*, was very highly commended by Col. Lane Fox. We can only state her general conclusion that cereals were introduced by pre-Aryan races of common descent over a very wide range of the world, and they also introduced the worship of the moon as an agricultural deity. The absence of agricultural implements in prehistoric remains proved their extreme simplicity; probably only a pointed stick was used, a form still persistent. Some of the stone celts may have been used as hoes, and flint flakes might also have been inserted in wooden frames for use as harrows. Furrows and ridges seemed to have been everywhere used.

Department of Anatomy and Physiology.

A valuable series of researches on certain special poisons was presented from the Owens College Laboratory, in papers separate or conjoint, by Prof. Gamgee, F.R.S., Mr Leopold Larmuth, and Dr John Priestley. Vanadium and its compounds have been specially investigated, and found to be irritant poisons, rapidly causing death, often preceded by paralysis, convulsions, &c. When much diluted the solutions act injuriously on bacteria, germinating seeds, fungi, &c. The results are the same whether the solution is injected into the skin, the veins, or the alimentary canal of higher animals. Both before and after division of the respiratory nervous centre, vanadium causes in the first instance a stimulation, and in the next a depression of respiration. When the muscles and nerves of a frog poisoned with vanadium were tested by electricity after reflex irritability was entirely destroyed, the work done by the muscles has [illegible] difference from that of non-poisoned muscles. The action of vanadium on the heart of frogs is curious; when vanadium is injected, the inhibitory centres acting on the auricles are not affected, but the vagus nerve loses its power of inhibiting the contraction of the ventricle. This result causes a dilemma which cannot yet be resolved, for it appears that vanadium is not a poison of the muscular fibre. Experiments have also been made on the relative poisonous activities of the ortho-, meta-, and pyro-phosphoric acids and their compounds, and they have been found to vary considerably in their intensity. Further, a relationship in the various phenomena produced has been made out between the different phosphates and vanadates. Investigations relating to chromium, in which rabbits, guinea pigs and frogs were employed, demonstrate considerable differences in its physiological action from that of vanadium. At first it induces irritation of the alimentary mucous membrane, and secondly it acts directly on the principal nervous centres, causing convulsions, paralysis, vomiting, a fall of blood pressure, and a sudden and temporary stoppage of the heart in dilatation. It is not specially a poison of muscle or of nerve trunks.

In the discussion which followed the reading of these papers, Prof. Kronecker, of Leipzig, expressed his opinion that the vanadates were really poisons of the muscular substance of the heart, and he accounted for the difference between the action on the auricle and ventricle by supposing a certain difference between the muscular substance of these two chambers. Dr M'Kendrick, who presided in this department, said that Prof. Gamgee's researches showed the advantage of the combination of the highest chemical with physiological knowledge, and they led to the hope that ultimately some definite law would be discovered regulating the relations between chemical constitution and physiological action. He held of [illegible] chemistry was a very [illegible] one [illegible] and much more likely to yield great results of [illegible] than the more complex considerations of organic chemistry. On one important point it was confirmed by Prof. Gamgee's investigation that [illegible] the molecule of a substance [illegible] was [illegible] operation, but this was affected also by the [illegible] of the molecule.

Prof. Gamgee also read a paper *On the Changes [illegible]*. The experiments were [illegible] cats. When the blood was expelled from [illegible] the heart [illegible], but only for a short time, and the immediate result followed the application of the bandage [illegible]. When the heart [illegible] to beat at its usual rate the tourniquets were loosened, and in an instant the limb, previously blanched, became suffused with a blush, while [illegible] more and more [illegible], and the heart [illegible] ingly rapid rate, to return, however, to its normal beat almost immediately. It has been suggested that the increase of the heart's beat when the bandage is applied is intimately connected with the diminution of the normal difference between arterial and venous pressure. It is [illegible] likely that [illegible] pressure on the right side of the heart tend to [illegible] of the heart, and the [illegible] the bandage round the limb was no doubt the result of the sudden diminution of internal pressure thus caused. Prof. Kronecker desired that it should not be lost sight of that the altered chemical composition of the blood also had an influence in this matter.

Dr Stirling, of Edinburgh, gave a very lucid account of his discovery of small nerve ganglia in many parts of the lung, and especially in relation to the bronchi at the base of the lung. These small collections of ganglion cells may be either in the course of the nerves or at their forks. They are directly continued at two extremities into the gray or sympathetic nerve-fibres. Dr Stirling believes that these were local nerve centres for the muscular fibres of the blood vessels, controlling their calibre, and thus regulating the amount of blood passing through them. Dr Gairdner threw out the idea that these local nerve-centres might have another function, that of regulating the capacity of different bronchi, and so varying the amount of air admitted to or expelled from particular regions of the lung. He had long believed that some such arrangement must exist, in consequence of stethoscopic observations both on the healthy and the diseased subject. Dr. Stirling suggested that this regulating power might reside in the higher nervous centres, for stimuli could be sent down through any limited number of fibres of the whole respiratory nerves. Many of the distinguished physiologists present expressed high praise of Dr. Stirling's abilities as shown in this research.

Department of Zoology and Botany

Mr. J. Gwyn Jeffreys, F.R.S., gave an account of the biological results of the voyage of the *Valorous* to Disco Island in 1875, which will be published in full in the *Proceedings* of the Royal Society. He urged the importance of repeated expeditions of this kind. A century of hard work would not suffice to collect all the information that was needed. Hitherto naturalists had only scraped the bottom of a few acres out of the many millions of square miles of the ocean. The British nation had hitherto done very little for submarine discovery in proportion to the poorer countries of Scandinavia, which had sent out expedition after expedition, yielding the most valuable results to science. Unfortunately, the latest intelligence as to the present Norwegian enterprise was that their work had been much interfered with by tempestuous weather. An important result of Mr. Jeffreys' experience was the bringing up of large and small stones, some very sharp, from the sea bottom at great depths. He thought telegraph engineers had not taken this sufficiently into account in the construction of cables, having proceeded as if they had only to deal with an entirely soft bottom. The number of species of mollusca obtained by the *Valorous* was 185, of which forty were new to science. His opinion, derived from personal knowledge of the American as well as of the European fauna, was that the submarine fauna of Davis Straits was predominantly European, although a number of American forms were found with them. An interesting feature was the discovery of a number of species previously only known in a fossil state in Tertiary rocks far distant, as in the Mediterranean; other species were remarkable because it was now for the first time shown what an enormous range in space and latitude they had, sometimes at least 1,200 miles. Dr. McIntosh, of St. Andrews, Prof. Dickie, of Aberdeen, and Dr. Carpenter gave addresses respectively on the Annelids, the Diatoms, and the Arenaceous Foraminifera brought home by the *Valorous*, and confirmed Mr. Gwyn Jeffreys in maintaining the predominance of European forms.

Mr. John Murray gave an address on oceanic deposits and their origin, based on observations on board the *Challenger*. He described and exhibited specimens of various kinds of deep-sea deposits. He did not think the detritus of the modern land was carried more than two or three hundred miles from the shore. A novel constituent of the deepest sea-bottoms was pumice dust, which had been found in almost every region, arising from submarine volcanic action. Mr. Murray thought he had never failed to find a piece of pumice, when it was carefully looked for, in any of the dredgings, and he believed it to be the chief origin of the deep-sea clay. Another element which appeared to have been detected at great depths was cosmic dust, or dust formed from aerolites. Another interesting point was that whenever they got into deep water, they found manganese peroxide in nodules inclosing organic remains—sharks' teeth and pieces of bone. This formation seemed to be connected with the disintegration of volcanic rocks. Mr. Murray also discussed the question whether true equivalents of the deep-sea deposits now made known were to be found in the series of stratified rocks. If this were not the case, then it must be held that the great continents had remained substantially the same throughout a vast length of time.

FORCE[1]

AT short notice it was not to be expected that I could produce a lecture which should commend itself to the Association by its novelty or originality. But in science there are things of greater value than even these—namely definiteness and accuracy. In fact without them there could not be any science except the very peculiar smattering which is usually (but I hope erroneously) called "popular." It is vain to expect that more than the elements of science can ever be made in the true sense of the word popular; but it is the people's *right* to demand of their teachers that the information given them shall be at least definite and accurate, so far as it goes. And as I think that a teacher of science cannot do a greater *wrong* to his audience than to mystify or confuse them about fundamental principles, so I conceive that wherever there appears to to be such confusion it is the *duty* of a scientific man to endeavour by all means in his power to remove it. Recent criticisms of works in which I have had at least a share, have shown me that, even among the particularly well-educated class who write for the higher literary and scientific journals, there is wide-spread ignorance as to some of the most important elementary principles of physics. I have therefore chosen, as the subject of my lecture to-night, a very elementary but much abused and misunderstood term, which meets us at every turn in our study of natural philosophy.

I may at once admit that I have nothing new to tell you, nothing which (had you all been properly taught, whether by books or by lectures) would not have been familiar to all of you. But if one has a right to judge of the general standard of popular scientific knowledge from the statements made in the average newspaper, or even from those made in some of the most pretentious among so-called scientific lectures, there can be but few people in this country who have an accurate knowledge of the proper scientific meaning of the little word Force.

We read constantly of the so-called "Physical Forces"—heat, light, electricity, &c.—of the "Correlation of the Physical Forces," of the "Persistence or Conservation of Force." To an accurate man of science all this is simply error and confusion, and I have full confidence that the inherent vitality of truth will render the attempt to force such confusion upon the non-scientific public quite as futile as the hopelessly ludicrous endeavour of the *Times* to make us spell the word chemistry with a Y instead of an E. It is true that in matters such as this it, a good deal depends (as Sam Weller said) on the taste and fancy of the speller—and sometimes even absolute error is of little or no consequence. But it is quite another thing when we deal with the fundamental terms of a science. He who has not exactly caught their meaning, is pretty certain to pass from chronic mistakes to frequent blunders, and cannot possibly acquire a definite knowledge of the subject.

In popular language there is no particular objection to multiple meanings for the same word. The context usually shows exactly which of these is intended; and their existence is one of the most fertile sources of really good puns, such as those of Hood, Hook, and Barham. And there is no reason to object to such phrases as the *force of habit*, the *force of example*, the *force of circumstances*, or the *force of public opinion*; but when we read, as I did but last week in one newspaper, that the "force" of a projectile from the 81-ton gun has at last reached the extraordinary amount of 1,450 feet, in another that the "force" of a ball from the great Armstrong gun, lately made for the Italian government, is expected to average somewhere about 30,000 foot-tons, and in a third that the water in the boilers of the *Thunderer* would in a second of time generate a "force" sufficient to raise 2,000 tons one foot high; we see that there must be, somewhere at least, if not everywhere, a most reckless abuse of language. In fact we have come to what ought to be scientific statements, and *there* even the slightest degree of unnecessary vagueness is altogether intolerable.

Perhaps no scientific English word has been so much abused as the word "force." We hear of "Accelerating Force," "Moving Force," "Centrifugal Force," "Living Force," "Projectile Force," "Centripetal Force," and what not. Yet, as William Hopkins, the greatest of Cambridge teachers, used to tell us—"Force is Force," *i.e.*, there is but one idea denoted by the word, and all force is of one kind, whether it be due to gravity, magnetism or electricity. This alone serves to give a preliminary hint that (as I shall presently endeavour to make clear to you) there is probably no such *thing* as force at all! That it is, in fact, merely a convenient expression for a certain "rate." If anyone should imagine that "3 per cent." is a sum of money, he will soon be grievously undeceived. "3 per cent." means nothing more nor less than the vulgar fraction $\frac{3}{100}$. True, the "*Three per Cents.*" usually means something very substantial; but there the term is not a scientific one. Think for a moment how utterly any one of you, supposed altogether ignorant of shipping, would be puzzled by such a newspaper heading as "*The White Star-Line*" or "*The Red Jacket Clipper*." No doubt some of our scientific terms approach as near to slang as do these; but we are doing our best to get rid of them.

A good deal of the confusion about Force is due to Leibnitz and some of his associates and followers, who, whatever they may have been as mathematicians, were certainly grossly ignorant of some elementary parts of dynamics, insomuch that Leibnitz himself is known to have considered the fundamental system of the *Principia* to be erroneous, and to have devised another and different system of his own. This fact is carefully kept back now-a-days, but it *is* a fact, and (as I have just said) has had a great deal to do with the vagueness of the terms *Force* and *Energy* in some modern languages. In fact, in their modern

[1] Evening lecture by Prof. Tait at the Glasgow meeting of the British Association, Sept. 8.

dress, the *Vis Viva*, *Vis Mortua*, and *Vis Acceleratrix* of that time have, in some of their Protean shapes, hooked themselves like Entozoa into the great majority of our text-books.

Before dealing more definitely with the proper meaning of the word "Force" I must briefly consider how we become acquainted with the physical world, and how consequently it is more than probable that some of our most profound impressions, if uninformed, are completely erroneous and misleading.

In dealing with physical science it is absolutely necessary to keep well in view the all-important principle that—

Nothing can be learned as to the physical world save by observation and experiment, or by mathematical deductions from data so obtained.

On such a text, volumes might be written; but they are unnecessary, for the student of physical science feels at each successive stage of his progress more and more profound conviction of its truth. He must receive it, at starting, as the unanimous conclusion of all who have in a legitimate manner made true physical science the subject of their study; and, as he gradually gains knowledge by this—*the only*—method, he will see more and more clearly the absolute impotence of all so-called metaphysics, or *à priori* reasoning, to help him to a single step in advance.

Man has been left entirely to himself as regards the acquirement of physical knowledge. But he has been gifted with various *senses* (without which he could not even know that the physical world exists) and with *reason* to enable him to control and understand their indications.

Reason, unaided by the senses, is totally helpless in such matters. The indications given by the senses, unless interpreted by reason, are utterly unmeaning. But when reason and the senses work harmoniously together, they open to us an absolutely illimitable prospect of mysteries to be explored. This is the test of true science—there is no resting-place—each real advance discloses so much that is new and easily accessible that the investigator has but scant time to co-ordinate and consolidate his knowledge before he has additional materials poured into his store.

To sight without reason, the universe appears to be filled with light—except, of course, in places surrounded by opaque bodies.

Reason, controlling the indications of sense, shows us that the sensation of light is our own property; and that what we understand by brightness, &c., does not exist outside our minds. It shows us also that the sensation of colour is purely subjective, the only difference possible between different so-called rays of light outside the eye being merely in the extent, form, and rapidity of the vibrations of the luminiferous medium.

To hearing, without reason, the air of a busy town seems to be filled with sounds. Reason, interpreting the indications of sense, tells us that if we could SEE the particles of air, we should observe among them simply a comparatively slow agitation of the nature of alternate compressions and dilatations superposed upon their rapid motions among one another. And our classification of sounds as to loudness, pitch, and quality, is merely the subjective correlative of what in the air-particles is objectively the amounts of compression, the rapidity of its alternations, and the greater or less complexity of the alternating motion.

A blow from a stick or a stone produces pain and a bruise; but the motion of the stick or stone before it reached the body is as different from the sensation produced by the blow as is the alternate compression and dilatation of the air from the sensation of sound, or the etherial wave-motion from the sensation of light.

Hence to speak, as the great majority even of "educated" people do, of what we ordinarily mean by light or sound, as existing outside ourselves, is as absurd as to speak of a swiftly-moving stick or stone as pain. But no inconvenience is occasioned if we announce the intention to use the terms light and sound for the objective phenomena, and to speak of their subjective effects as "luminous impressions" or "noise," as the case may be. In this case there is outside us energy of motion of every kind, but in the mind mere corresponding impressions of brightness and colour, noise or harmony, pain, &c., &c.

As another instance, it is obvious that we must be extremely cautious in our interpretation of the immediate evidence of our own senses as to heat.

Touch, in succession, various objects on the table. A paper-weight, especially if it be metallic, is usually cold to the touch; books, paper, and especially a woollen table-cover, comparatively warm. T[illegible] *thermometer* [illegible] not by the sense of touch, and in all probability you will find little or no difference in what we call their *temperatures*. In fact, any number of bodies of any kind shut up in an inclosure (within which there is no fire or other source of heat) all tend to acquire ultimately the same temperature. Why, then, do some feel cold, others warm to the touch?

The reason is simply this—the sense of touch does *not* inform us directly of temperature, but of *the rate at which our finger gains or loses heat*. As a rule bodies in a room are colder than the hand, and heat always tends to pass from a warmer to a colder body. Of a number of bodies, all equally colder than the hand, that one will seem coldest to the touch which is able *most rapidly* to convey away heat from the hand. The question, therefore, is one of *conduction of heat*. And to assure ourselves that it is so, reverse the process: *let us*, in fact, *try an experiment*, though an exceedingly simple one; for the essence of experiment is to modify the circumstances of a physical phenomenon so as to increase its value as a test. Put the paper-weight, the books, and the woollen table-cloth into an oven, and raise them all to one and the same temperature—considerably above that of the hand. The woollen cloth will still be comparatively cool to the touch, while the metal paper-weight may be much too hot to hold. The order of these bodies, as to warm and cold, in the popular sense, is in fact reversed; and this is so because the hand is now *receiving* heat from all the various bodies experimented on, and it receives most rapidly from those bodies which in their previous condition were capable of abstracting heat most rapidly. However it may be in the moral world, in the physical universe the giving and taking powers of one and the same body are strictly correlative and equal.

Thus the direct indications of sense are in general utterly misleading as to the relative temperatures of different bodies.

In a baker's oven, at temperatures far above the boiling point of water (on one occasion even 320° F., so high indeed that a beef-steak was cooked in thirteen minutes), Tillet in France, and Blagden and Chantrey in England, remained for nearly an hour in comparative comfort. But though their clothes gave them no great inconvenience, they could not hold a metallic pencil-case without being severely burned.

On the other hand, great care has to be taken to cover with hemp, or wool, or other badly conducting substance, every piece of metal which has to be handled in the intense cold to which an Arctic expedition is subjected; for contact with very cold metal produces sores almost undistinguishable from burns, though due to a directly opposite cause. Both of these phenomena, however, ultimately depend on the comparative facility with which heat is conducted by metals.

Even from the instance just given, you cannot fail to see that there is a profound distinction between heat and temperature. Heat, whatever it may be, is SOMETHING which can be transferred from one portion of matter to another; the consideration of temperatures is virtually that of the mere CONDITIONS which determine whether or not there shall be a transfer of heat, and in which direction the transfer is to take place. Bear this carefully in mind, because it has most important analogies to the results we meet with in considering the nature of Force.

It has been definitely established by modern science that *heat, though not material, has objective existence in as complete a sense as matter has.*

This may appear, at first sight, paradoxical; but we must remember that so-called paradoxes are merely facts as yet unexplained, and therefore still apparently inconsistent with others already understood in their full significance.

When we say that matter has objective existence, we mean that it is something which exists altogether independently of the senses and brain-processes by which alone we are informed of its presence. An exact or adequate conception of it, if it could be formed, would probably be something very different from any conception which our senses will ever enable us to form; but the object of all pure physical science is to endeavour to grasp more and more perfectly the nature and laws of the external world, using the imperfect means which are at our command—reason acting as interpreter as well as judge, while the senses are merely more or less untrustworthy and incompetent witnesses, but still of inconceivable value to us because they are our only available ones.

Without further discussion we may state once for all that our conviction of the objective reality of matter is based mainly upon the fact, *discovered solely by experiment*, that we cannot in the slightest degree alter its quantity. We cannot destroy, nor can we produce, even the smallest portion of matter. But reason

requires us to be consistent in our logic; and thus, if we find anything else in the physical world whose quantity we cannot alter, we are bound to admit it to have objective reality as truly as matter has, however strongly our senses may predispose us against the concession. Heat therefore, as well as light, sound, electricity, &c., though not forms of matter, must be looked upon as being as real as matter, simply because they have been found to be forms of energy—which in all its constant mutations satisfies the test which we adopt as conclusive of the reality of matter. We shall find that this test fails when applied to force.

But you must again be most carefully warned to distinguish between heat and the mere sensation of warmth; just as you distinguish between the motion of a cudgel and the pain produced by the blow. The one is the *thing* to be measured, the other is only the more or less imperfect reading or indication given by the instrument with which we attempt to measure it in terms of some one of its effects. So that when your muscular sense impresses on you the notion that you are exerting force as in pushing or pulling, you ought to be very cautious in forming a judgment as to what is really going on; and you ought to demand much farther evidence before admitting the objective reality of force.

Until all physical science is reduced to the deduction of the innumerable mathematical consequences of a few known and simple laws, it will be impossible altogether to avoid some confusion and repetition, whatever be the arrangement of its various parts which we adopt in bringing them before a beginner. But when we confine ourselves to one definite branch of the subject, all of whose fundamental laws can be distinctly formulated, there need be no such confusion. Here in fact the mathematician has it all in his own hands. He is the skilled artificer with his plan and his trowel, and the hodmen have handed up to him all the requisite bricks and mortar.

[Prof. Tait then gives a quotation in support of this view.]

Whether there is such a *thing* as force or not I shall consider presently. But in the meanwhile there can be no doubt that it is a convenient term, provided it be employed in one definite sense, and one only. Let us then first see how it is to be correctly used. Here we cannot but consult Newton. The sense in which he uses the word "force," and therefore the sense in which we must continue to use it if we desire to avoid intellectual confusion, will appear clearly from a brief consideration of his simple statement of the law of motion.

The first of these laws is: *Every body continues in its state of rest or of uniform motion in a straight line, except in so far as it is compelled by impressed forces to change that state.*

In other words, any change, whether in the *direction* or in the *rate* of motion of a body is attributed to *force*. Thus a stone let fall moves quicker and quicker, and we say that a force (*viz.*, the weight of the stone, or the earth's attraction for it) is continually acting so as to increase the *rate* of the motion. If the stone be thrown upwards, the *rate* of its motion continually diminishes, and we say that the same force (the stone's weight) is continually acting so as to produce this diminution of speed. So far, none of you probably feels the least difficulty. But we have got only half of the information on this point which Newton's first law affords. You see the moon revolving about the earth, and the earth and other planets revolving about the sun—approximately, at least, in circles. Why is this? Their *directions* of motion are constantly changing; in fact, a curved line is merely a line whose direction changes from point to point, while a straight line is one whose direction does not change; but to produce this change of direction force is required just as much as to produce change of speed. That is supplied by the gravitation attraction of the central body of the system. The old notion was that a centripetal force was required to balance the so-called centrifugal force, it being imagined that a body moving in a circle had a tendency to fly outwards from the centre! Newton's simple law exposes fully the absurdity of this. If a body is to be made to move in a curved line instead of its natural straight path, you must apply force to compel it to do so; certainly not to prevent it from flying outwards from the centre, about which it is for the moment revolving. In fact, inertia means, not revolutionary activity, but dogged perseverance, and just as you must apply force *in* the direction of motion to change the *rate* of motion, so must you apply force *perpendicular* to the direction of motion to change that *direction*.

Newton's second law is now required: *Change of motion is proportional to the impressed force, and takes place in the direction of the straight line in which the force acts.*

Mark here most carefully that this one simple law holds for *all* kinds of force alike. There is no special law for gravitation-force and others for electric and magnetic forces. All are defined alike, without reference to their origin.

Motion, as Newton has previously defined it, is here used as a technical scientific term for what we now call *momentum*. It is the product of the mass moving into the velocity with which it moves. "Change of motion," therefore, is change of momentum, or the product of the mass of the moving body into its change of velocity. Now a change of velocity is itself a velocity, as we see by the science of mere motion—kinematics—the purely mathematical science of mixed space and time.

Newton's words, however, imply more than this. Of course, the longer a given force acts, the greater will be the change of momentum which it produces; so that to compare forces, which is the essence of the process of measuring them, we must give them equal times to act—or, in scientific language, we must measure a force by the *rate* at which it produces change of momentum. Rate of change of velocity is called in kinematics acceleration. Thus the measure of a force is the product of the mass of the body moved into the acceleration which the force produces in it. This is the so-called *Vis motrix*, or "moving force" of the Cambridge text-books.—the so-called *Vis acceleratrix*, or "accelerating force," being really no force at all, but another name for the kinematical quantity acceleration which I have just defined.

Unit force is thus that force which, *whatever be its source*, produces unit momentum in unit of time. If we employ British units unit of force is that which, in one second, gives to one pound of matter a velocity of one foot per second. Here you must carefully notice that a *pound* of matter is a certain *mass* or quantity of matter. When you buy a pound of tea, you buy a quantity of the matter called tea, equal in *mass* to the standard pound of platinum. The idea of weight does not enter primarily into the process. In fact, the use of an ordinary balance depends upon one clause of Newton's law of gravitation which tells us that in any locality whatever, the weights of bodies are equal if their masses are equal. The weight of a pound of matter varies from place to place on the earth's surface it depends on the attracting as well as the attracted body. The mass of a body is its own property. The earth's attraction for a body, or the weight of the body, is a force which produces in it in one second, a velocity which (in this latitude, and at the sea-level) is about 32·2 feet per second. So that, in Glasgow the weight of a pound which we take as our standard of mass is rather more than thirty-two units of force, or, what comes to the same thing, the British unit of force is about the former weight of a penny letter—half an ounce.

Some people are in the habit of confounding force with momentum. No one having sound ideas of even elementary mathematics could be guilty of this or any similar monstrosity. He would as soon, as Hopkins used to say, measure heights in acres, or arable land in cubic miles. But to show to a non-mathematician that it is really monstrous to confound force and momentum, it suffices to change the system of units employed in measuring them, when it will be found that, if numerically equal for any one system of units, they are necessarily rendered unequal by a mere change of the unit employed for time. Now two things which are really equal to one another must necessarily be expressed by the same numerical quantity *whatever* system of units be adopted. Let us try then unit of force and unit of momentum, as defined by pound, foot, second, units: and see what alterations a common change of these fundamental units will make in their numerical expression.

Unit momentum is that of one pound of matter moving with a velocity of one foot per second. Unit force is that force which, acting for one second, produces in unit of mass a velocity of one foot per second. In each of these statements you may put an ounce or a ton, instead of a pound, and an inch or a mile in place of a foot, and their relative value will not be altered. But suppose we take a minute instead of a second as the unit of time. One foot per second is sixty feet per minute—so this change of the time unit increases sixty-fold the nominal value of the momentum considered. But in the case of the force our statement would stand thus:—What we formerly called unit of force is that which, acting for one-sixtieth only of our new unit of time produces in a mass of one pound, sixty-fold the new unit of velocity. In other words the number expressing the momentum is increased sixty-fold, while that representing the force is increased three thousand six hundred fold.

In fact, whatever be the system of units you employ—if you increase in any proportion the unit of time, the measure of a

momentum is increased, in that proportion simply, while that of a force is increased in the duplicate ratio. The two things are, therefore, of quite dissimilar nature, and cannot lawfully be equated to one another under any circumstances whatever.

The mathematician expresses this distinction at once by saying that momentum is the time-integral of force, because force is the rate of change of momentum.

But what I have already said as to the meaning of Newton's two first laws leaves absolutely no doubt as to the only definite and correct meaning of the word force. It is obviously to be applied to any pull, push, pressure, tension, attraction, or repulsion, &c., whether applied by a stick or a string, a chain or a girder; or by means of an invisible medium such as that whose existence is made certain by the phenomena of light and radiant heat, and which has been shown with great probability to be capable of explaining the phenomena of electricity and magnetism.

I have already mentioned to you that the notion of force is suggested to us by the so-called muscular sense, which gives us a peculiar feeling of pressure when we attempt to move a piece of matter. To get a notion of what it really means we must again have recourse to physical facts instead of the uncontrolled evidence of the senses. Almost all that is required for this purpose is summed up for us in the remaining law of motion. Before we take it up, however, let us briefly consider the position at which we have arrived.

We have seen how to get rid of two gratuitous absurdities—the so called centrifugal force and accelerating force, and we must proceed to exterminate living force. Cormoran and Blunderbore have been disposed of, but a more dangerous giant remains. More dangerous because he is a reality, not a phantom like the other two. Whatever force may be, there is no such thing as centrifugal force; and accelerating force is not a physical idea at all. But that which is denoted by the term living force, though it has absolutely no right to be called force, is something as real as matter itself. To understand its nature we must have recourse to another quotation from the *Principia*.

Newton's third law of motion is to the effect that—

"*To every action there is always an equal and contrary reaction: or, the mutual actions of any two bodies are always equal and oppositely directed.*"

This law Newton first shows to hold for ordinary pressures, tensions, attractions, impacts, &c., that is for *forces* exerted on one another by two bodies, or their time-integrals. And when he says—"If any one presses a stone with his finger his finger is pressed with an equal and opposite force by the stone," we begin to suspect that force is a mere name—a convenient abstraction—not an objective reality.

Pull one end of a long rope, the other being fixed. You can produce a practically *infinite* amount of force, for there is stress across every section throughout the whole length of the rope. Press upon a movable piston in the side of a vessel full of fluid. You produce a practically infinite amount of force—for across every ideal section of the liquid a pressure per square inch is produced equal to that which you applied to the piston. Let go the rope, or cease to press on the piston, and all this practically infinite amount of force is gone!

The only man who, to my knowledge, ever tried to discover experimentally what might be correctly called *conservation of force*, was Faraday. He was not satisfied with the mode of statement of Newton's law of gravitation, in which the mutual attraction between two bodies is said to VARY inversely as the square of their distance from one another. When the distance between two bodies is doubled, their mutual attraction falls off to one-fourth of what it formerly was. Faraday seriously set to work to determine what became of the three-fourths which have disappeared, but all his skill was insufficient to give him any result. Faraday's insight was so profound that we cannot assert that something may not yet be discovered by such experiments, but it will assuredly not be a conservation of force.

But Newton proceeds to point out that this third law is true in another and much higher sense. He says:—

"*If the action of an agent be measured by the product of its force into its velocity; and if, similarly, the reaction of the resistance be measured by the velocities of its several parts into their forces, whether these arise from friction, cohesion, weight, or acceleration, action and reaction, in all combinations of machines, will be equal and opposite.*"

The actions and reactions which are here stated to be equal and opposite, are no longer simple forces, but the *products* of forces into their velocities; *i.e.*, they are what are now called *rates of doing work*; the time-rate of increase, or the increase per second of a very tangible and real SOMETHING, for the measurement of which rate Watt introduced the practical unit of a *horse-power*, or the rate at which an agent works when it lifts 33,000 pounds 1 foot high per minute against the earth's attraction.

Now think of the difference between raising a hundredweight and endeavouring to raise a ton. With a moderate exertion you can raise the hundredweight a few feet, *and in its descent it might be employed to drive machinery, or to do some other species of work*. But tug as you please at the ton, you will not be able to lift it; and therefore, after all your exertion, it will not be capable of doing any work by descending again.

Thus it appears that *force* is a mere name, and that the *product of a force into the displacement of its point of application* has an objective existence. In fact, modern science shows us that force is merely a convenient term employed for the present (very usefully) to shorten what would otherwise be cumbrous expressions; but it is not to be regarded as a *thing*, any more than the bank *rate of interest* (be it 2, $2\frac{1}{2}$, or 3 per cent.) is to be looked upon as a sum of money, or than the birth-rate of a country is to be looked upon as the actual group of children born in a year. Another excellent instance is to be had from the rainfall. We say rain fell on such a day at the rate of an inch in twenty-four hours. What *can* be an inch of rain? especially when we mean a *linear*, not a *cubic* inch. But there is no confusion or absurdity here. What is implied is that, if it had gone on raining at that rate for twenty four hours, and if the rain (like snow) remained where it fell, the ground would have been coated to the depth of an inch.

In fact, a simple mathematical operation shows us that it is precisely the same thing to say:—

The horse power or amount of work done by an agent in each second is the product of the force into the average velocity of the agent,

and to say—

Force is the rate at which an agent does work per unit of length.

In the special illustration of Newton's words which I have just given, the resistance was a *weight*, that of a hundredweight or of a ton. When the resistance was overcome, work was done, and it was stored up for use in the raised mass—in a form which could be made use of at any future time.

Following a hint given by Young, we now employ the term ENERGY to signify the power of doing work, in *whatever* that power may consist. The raised mass, then, we say possesses, in virtue of its elevation, an amount of energy precisely equal to the work spent in raising it. This dormant, or passive, form is called *potential* energy. Excellent instances of potential energy are supplied by water at a high level, or with a "head," as it is technically called, in virtue of which it can in its descent drive machinery—by the wound-up "weights" of a clock, which in their descent keep it going for a week; by gunpowder, the chemical affinities of whose constituents are called into play by a spark, &c., &c.

Another example of it is suggested by the word "cohesion," employed in Newton's statement, and which must be taken to include what are called molecular forces in general, such as, for instance, those upon which the elasticity of a solid depends.

When we draw a bow, we do work, because the force exerted has a velocity; but the drawn bow (like the raised weight) has in potential energy the equivalent of the work so spent. That can in turn be expended upon the arrow; and *what then?*

Turn, again, to Newton's words, and we see that he speaks of one of the forms of resistance as arising from "acceleration." In fact the arrow, by its inertia, resists being set in motion; work has to be spent in propelling it, but the moving arrow has that work in store in virtue of its motion. It appears from Newton's previous statements that the measure of the rate at which work is spent in producing acceleration is *the product of the momentum into the acceleration in the direction of motion*, and the energy produced is measured by *half the product of the mass into the square of the velocity produced in it*. This active form is called *kinetic* energy, and it is the double of this to which the term *vis viva*, or *living force*, has been erroneously applied.

As instances of ordinary kinetic energy, or of mixed kinetic and potential energies, take the following:—A current of water capable of driving an undershot wheel; winds, which also are used for driving machinery; the energy of water-waves or of sound waves; the radiant energy which comes to us from the sun, whether it affect our nerves of touch or of sight (and there-

fore be called radiant heat or light) or produce chemical decomposition, as of carbonic acid and water in the leaves of plants, or of silver salts in photography (and be therefore called actinism); the energy of motion of the particles of a gas, upon which its pressure depends, &c. [When the motion is vibratory the energy is generally half potential, half kinetic.]

These explanations and definitions being premised, we can now translate Newton's words (without alteration of their meaning) into the language of modern science, as follows:—

Work done on any system of bodies (in Newton's statement the parts of any machine) *has its equivalent in work done against friction, molecular forces, or gravity, if there be no acceleration; but if there be acceleration, part of the work is expended in overcoming the resistance to acceleration, and the additional kinetic energy developed is equivalent to the work so spent.*

But we have just seen that when work is spent against molecular forces, as in drawing a bow or winding up a spring, it is stored up as potential energy. Also it is stored up in a similar form when done against gravity, as in raising a weight.

Hence it appears that, according to Newton, whenever work is spent it is stored up either as potential or as kinetic energy, except, possibly, in the case of work done against friction, about whose fate he gives us no information. Thus Newton expressly tells us that (except, possibly, when there is friction) *work is indestructible*, it is changed from one form of energy to another, and so on, but never altered in quantity. To make this beautiful statement complete, all that is requisite is to know *what becomes of work spent against friction.*

Here, of course, experiment is requisite. Newton, unfortunately, seems to have forgotten that savage men had long since been in the habit of making it whenever they wished to procure fire. The patient rubbing of two dry sticks together, or (still better) the drilling of a soft piece of wood with the slightly blunted point of a hard piece, is known to all tribes of savages as a means of setting both pieces of wood on fire. Here, then, heat is undoubtedly produced, *but it is produced by the expenditure of work.* In fact work done against friction has its equivalent in the heat produced. This Newton failed to see, and thus his grand generalisation was left, though on one point only, incomplete. The converse transformation, that of heat into work, dates back to the time of Hero at least. But the knowledge that a certain process will produce a certain result does not necessarily imply even a notion of the "why;" and Hero as little imagined that in his æolipile heat was *converted into work*, as do savages that work can be *converted into heat.*

But whenever any such conversion or transference takes place there is necessarily motion: and the mere rate of conversion or transference of energy per unit length of that motion is, in the present state of science, very conveniently called force. No confusion can arise from using such a word in such a sense. On the contrary, there is always a gain in clearness when compactness can lawfully be introduced.

Rumford and Davy, at the very end of last century, by totally different experimental processes, showed conclusively that the materiality of heat could not be maintained, and thus gave the means of completing Newton's statement which, still farther extended and generalised rather more than thirty years ago by the magnificent experimental work of Colding and Joule, now stands as one massive pillar of the fast-rising temple of science:—known as the law of the *conservation of energy.*

The conception of kinetic energy is a very simple one, at least when visible motion alone is involved. And from motion of visible masses to those motions of the particles of bodies whose energy we call heat, is by no means a very difficult mental transition. Mark, however, that heat is not the mere motions but the energy of these motions; a very different thing, for heat and kinetic energy in general are no more "*modes of motion*" than potential energy of every kind (including that of unfired gunpowder) is a "*mode of rest!*" In fact a "*mode of motion*" is, if the word motion be used in its ordinary sense, purely kinematical, not physical; and if motion be used in Newton's sense, it refers to momentum, not to energy.

The conception of potential energy, however, is not by any means so easy or direct. In fact, the apparently direct testimony of our muscular sense to the existence of force makes it at first much easier for us to conceive of force than of potential energy. *Why* two masses of matter possess potential energy when separated—in virtue of which they are conveniently said to attract one another—is still one of the most obscure problems in physics. I have not now time to enter on a discussion of the very ingenious idea of the ultramundane corpuscles, the outcome of the life-work of Le Sage, and the only even apparently hopeful attempt which has yet been made to explain the mechanism of gravitation. The most singular thing about it is that, if it be true, it will probably lead us to regard all kinds of energy as ultimately kinetic.

And a singular quasi-metaphysical argument may be raised on this point, of which I can give only the barest outline. The mutual convertibility of kinetic and potential energy shows that relations of equality (though not necessarily of identity) can exist between the two, and thus that their proper expressions involve the same fundamental units, and in the same way. Thus, as we have already seen that kinetic energy involves the unit of mass and the square of the linear unit directly, together with the square of the time unit inversely, the same must be the case with potential energy; and it seems very singular that potential energy should thus essentially involve the unit of time if it do not ultimately depend in some way on energy of motion.

[Prof. Tait then gives instances of the inaccurate use of the word Force.]

To conclude—In defence of accuracy, which is the *sine quâ non* of all science, we must be "zealous," as it were, even to "slaying." And, as all the power of the *Times* will not compel us to put a *y* instead of an *e* into the word chemist, so neither will the bad example of Germany and France, though recommended to us with all the authority which may be attributed to an ex-president of this Association, succeed in inducing us to attach two or more perfectly distinct and incompatible scientific meanings to that useful little word, "force," which Newton has once and for ever defined for us with his transcendent clearness of conception.

I have now only to ask your indulgence for the crudeness of this lecture. All I can say is that in preparing it, I have done my best, under circumstances of time, place, and surroundings, all alike unpropitious. But the chance of being able to back up, however imperfectly, my old friend, Dr. Andrews, in whose laboratory I first learned properly to use scientific apparatus, and whose sage counsel impressed upon me the paramount importance of scientific accuracy, and above all, of scientific honesty—such a chance was one which no surroundings (however unpropitious) could have induced me to forego.

NOTES

We have received the "Daily Programme of the Twenty-fifth Meeting of the American Association," held at Buffalo, August 23-30. It forms a pamphlet of about 100 pages, but appears to have been published daily during the meetings, and is quite a model of what such a programme should be. It is clearly printed on excellent paper, and has not the overcrowded appearance that the programme of the British Association often presents. At the last meeting a standing committee was appointed to superintend the selection of papers, and to this committee a short abstract must be sent before the title of a paper can be transmitted to the sectional committees. A list of accepted papers is given each day, and appended is the time each is supposed to occupy in reading. The work of each section for each day is indicated, and all the necessary information as to officers, regulations, &c., are given. A list is also given daily of the number of members "elected" and the number "registered," with their addresses. Altogether for this meeting there amount to 352, and the number of papers entered for reading is 147. At this meeting seventeen fellows were elected, consisting of some of the best known names in American science. The next meeting of the Association will be held at Nashville, Tenn., on the last Wednesday of August, 1877, the president-elect being Prof. Simon Newcomb, of Washington.

Prof. Huxley was present at the meeting of the American Association for the Advancement of Science, held at Buffalo. After stating that he was quite unprepared to occupy their attention, he said:—In England we have no adequate idea of the extent of your country, its enormous resources, the distances from centre to centre of population, and we least of all understand the great basis of character which sprung from the other side of the Atlantic. There has been some talk of the influence of your climate carrying you back to the North American type.

I cannot say that I can see any signs of that unless it be in the development of that virtue of hospitality which prevails among all savages. Another feature I have observed which fills me with a certain amount of shame, when I think of what is going on in our country. I have visited your great Universities of Yale and Harvard, and have seen how your wealthy men contribute to scientific institutions in a way to which we are totally unaccustomed in England. The general notion of an Englishman who becomes rich is to buy an estate and found a family. The general notion of an American who becomes rich is to do something for the benefit of the people, and to found an institution whose benefits shall flow to all. I need hardly say which I regard as the noblest of these two. It is commonly said there are no antiquities in America, and you have to come to the Old World to see the past. This may be, so far as regards the trumpery of 3,000 or 4,000 years of human history. But, in the larger sense America is the country to study antiquity. I confess that the reality somewhat exceeded my expectations. It was my great good fortune to study in Newhaven the excellent collection made by my good friend, Prof. Marsh. There does not exist in Europe anything approaching it as regards extent and the geological time it covers, and the light it throws on the wonderful problem of evolution which has been so ably discussed before you by Prof. Morse, and which has occupied so much attention since Darwin's great work on species. Before the gathering of such materials as those to which I have referred, evolution was a matter of speculation and argument, though we who had adhered to the doctrine had good grounds for our belief. Now things are changed, and it has become a matter of fact and history. The history of evolution, as a matter of fact, is now distinctly traceable. We know it has happened, and what remains is the subordinate question of how it happened. I wish you all good speed, and that this Association, like its sister in Great Britain, will sow the seeds of scientific inquiry in all the towns it visits, and thus help on the great good work."

ON Tuesday the proceedings of the Iron and Steel Institute were formally opened at Leeds, Mr. W. Menelaus, President, in the chair. The choice of President for the ensuing Session has fallen upon Dr. C. W. Siemens, F.R.S. The geological features of the neighbourhood of Leeds was the subject of an interesting and valuable paper by Prof. Green, F.G.S., of the Yorkshire College of Science, read by the Secretary. The paper was descriptive of the various geological formations of the district, the coal measures and the iron deposits being specially referred to. Referring to the coal mines of the district, he observed that there was an area of forty square miles upon which no coal had as yet been raised, although it was well known that coal-seams existed beneath the surface. A very small proportion only of the Yorkshire coal-fields had as yet been worked, a large area remaining untouched which contained the vast store of coal for future use. A paper was read by Mr. Dove, junior, on the North Lincolnshire Iron District. The author described the new iron district of North Lincolnshire, the centre of which is Frodingham. It appears the district has only been known for the past fifteen years, during which time its rise and development have been steady and rapid. The question of the open *versus* close-topped blast-furnaces was then discussed. Mr. J. Lowthian Bell, M.P., observed that as far as economy of fuel in the smelting process was concerned, there was not much to choose between the two systems in ordinary practice; where the real economy lay in close-topped furnaces was in the utilisation of the gases from the furnace for heating the steam boilers and the stoves. Mr. John Jones, the secretary of the Institute, then read a paper on technical education in connection with the iron trade. He observed that the great hindrance which had hitherto been experienced in dealing with technical education had been the unsatisfactory condition of primary education in England. Most of the time of the meeting during the week will be occupied in visiting the various industrial establishments in Leeds and neighbourhood.

AMONG the papers read at the Oriental Congress, in addition to those already mentioned, are the following:—Mr. Smirnow read an account of a Turkish MS. in the University Library of St. Petersburg, "On the Mythology of the Asiatic Peoples." The age of this MS. he thinks to be the 17th century. Prof. de Rosny then discussed with much learning and at considerable length the comparative philology of the languages vaguely styled Turanian, the meaning and application of which term he critically investigated. He thought there was as safe a basis for the scientific classification of these tongues—comprising the Chinese, Japanese, Tatar, Finnish, Basque, &c.—as there was acknowledged to be for that of the Aryan and Semitic languages. M. Slovstof read an interesting paper on "The History of Public Instruction in Western Siberia," and M. Neumann one on the Tchouktchis, a generic name for three different peoples who inhabit the whole of North-East Siberia viz., (1) the Rennes, (2) the Aigwanes, (3) the Nammolo. M. Sobruk, an Ostiak gentleman, read a memoir of great interest on the idols of his people and the Voguls, which, however, were no longer worshipped in public, or at least very rarely. Those which exist are confined to the huts of the believers. M. Solovief gave an ethnographical survey of the Samoied tribes of Siberia. Mr. Bonnell introduced the subject of the Scytho-Sarmatians and other inhabitants of the coasts of the Euxine, whose fortunes and history he elaborately traced in the pages of successive chroniclers, beginning with Herodotus. A communication by M. Schmidt, of Gevelsberg, after tracing the origin of Egyptian civilisation to Mesopotamia, from which it migrated to the Nile across the Persian Gulf, by way of Arabia and Ethiopia, was chiefly interesting for the attention he drew to the striking analogies in the languages of the American tribes with those of the Armeno-Caucasians, which were altogether too intimate, too frequent, and too decided to allow of the entertainment of any hypothesis of accidental similarity. From this suggestive line of thought M. Schmidt passed on to the consideration of the ethnological antiquities of the Medes, the bulk of whom he believed to be an Iranian people. M. Oppert developed his ideas upon the cuneiform texts written in the language of ancient Armenia and called Armeniac, but having no affinities with the language known as Armenian. M. Sachau strongly urged the importance of studying the scientific literature of the Arabs, and praised most warmly the services rendered to such studies by the publications of the St. Petersburg Academy, instancing the translation of Abderahman al Sufi's "Description of the Fixed Stars." Many other subjects of importance, mainly relating to the traditions, mythology, history, and literature of the varied peoples of the vast Russian territory, were discussed. The Congress will hold its next meeting at Florence.

THE paper by Mr. J. A. Broun "On Simultaneous Variations of the Barometer" (*Proc.* Roy. Soc., No. 171, 1876), is remarkable as raising the inquiry whether there may not be other causes of varying atmospheric pressure than change of the mass of air, in other words, whether the attraction of gravitation be the only force concerned in the barometric oscillations. It is shown from observations made at places in Europe, Asia, Australasia, Africa, and America during the week March 31 to April 5, 1845, that all the curves exhibit a maximum near the beginning and another near the end of the week, with a minimum near the middle, and it is inferred that we have here an indication of the general action of the same cause of barometric variation over the earth. Since it would be impossible to over-estimate the importance of the point here raised if it should turn out to be correct, we shall look forward with much interest to the further investigation of the subject promised us by Mr. Broun. In this connection the

International Charts of General Myer, of the United States, will be of the very greatest value.

IN a recent number of *Poggendorff's Annalen*, Dr. G. Berthold makes an interesting contribution to the history of the radiometer. It appears that in a paper entitled "Eclaircissement sur le traité physique et historique de l'aurore boréale," published in the *Mémoirs* of the Paris Academy for 1747, M. Mairan gives a description of a light mill. This was a horizontal wheel of iron about 3 inches in diameter, having six radii; at the end of each radius was a small oblique vane. The axis of the wheel was held by its upper point to the end of a magnetic bar. The weight was only thirty grains. Light was concentrated on it with a lens. "Nothing could be more mobile," says M. Mairan, "than this wheel; but at the same time nothing is less certain than the induction one might wish to draw from it in favour of an impulsion by the rays. The machine turns now in one direction, now in the other, according as you bring one of its vanes more or less near to the bars, within, or beyond the latter. It is necessary to conclude that the luminous rays attract and repel at different points of the cone which is formed by the lens, but the explosion of a mass of air suddenly and unequally heated round the vane where the focus is applied, appears to me to give a sufficient reason for these effects. The perpetual obstacle of the air naturally suggested to me to make one of these experiments *in vacuo*, but I avow that after having reflected a little on what might be the result, I have not thought it worth while taking the trouble." The reasons which thus unfortunately prevented M. Mairan from repeating his experiments *in vacuo* were, (1) the difficulty of producing a sufficient vacuum; (2) the idea, that besides the atmospheric air there was another fluid, which would penetrate the glass and make the experiment doubtful; (3) through action of the burning-glass vapours would rise from the body *in vacuo*, which would, by their impulsion, set it in motion. Dr. Berthold further notices an observation by Michell in Priestley's "History of Optics;" a piece of piano string, 10 in. long, having a square copper plate at one end, and a grain of shot at the other, was pivoted in a case having its cover and one side of glass. Solar rays directed from a concave mirror on the copper plate produced repulsion. Priestly considered that this motion must not be attributed to impact of the light rays.

THE French *Journal Official* publishes a letter from Shanghai stating that a Chinese Polytechnic Institution, supported by private contributions, has been opened there.

PETERMANN'S *Mittheilungen* for September contains some papers of great interest. Dr. Hermann Wagner, of Konigsberg, contributes a careful and detailed *résumé* of the most recent trustworthy contributions to a knowledge of the Bolivian littoral, its physical features, product, and people, accompanied by a map. Oscar Loew gives the results of Lieut. Wheeler's expedition in California, Nevada, and Arizona for the year 1875, the ... being embodied in a map by Dr. Petermann. Lieut. Weyprecht's "Pictures from the High North" are continued, the present instalment giving an interesting account of the behaviour of the sailors of the expedition in the ice. The Brazilian engineer, Maximilian Emerich, describes the various projects that have been proposed for a South American Pacific railway, and Dr. Mupperg, of Venice, contributes a picturesque paper on the German element, which is very strong, in Italy, especially in South Tyrol.

A HURRICANE burst over St. Thomas and St. Croix on the night of the 12th inst. The damage done was not extensive. Rain fell in torrents the whole time.

SNOW has been observed not only in Scotland on the Grampians, but on the Observatory of Puy-de-Dôme, on the 12th instant, and on the Alps round St. Jeanne, Maurienne, and other places, about the same time.

HER Majesty has directed letters patent to be passed under the Great Seal declaring that the degrees of Bachelor and Master in Arts, and Bachelor and Doctor in Law, Medicine, and Music, hereafter to be granted or conferred by the University of New Zealand, shall be recognised as academic distinctions and rewards of merit, and be entitled to rank, precedence, and consideration in the United Kingdom, and in the colonies and possessions of the crown throughout the world, as fully as if the said degrees had been granted by any university of the said United Kingdom.

THE Dutch Government has ordered from the French International Metric Commission, a copy of the standard metre, to be executed at its own expense. The same thing has been done already for the English Government.

ON Oct. 1 the first number of *The Sunday Review* will be published by Trubner and Co. It will be a shilling quarterly magazine, the organ of the Sunday Society, whose object, our readers know, is to obtain the opening of museums, art galleries, libraries, aquariums, and gardens on Sundays.

PART I., Vol. 1, of the *Proceedings* of the West London Scientific Association has been published. It contains the inaugural address of the President, the Rev. G. Henslow, for 1875-6, and a report of the meetings to the end of last year.

THE system of forest conservancy which is proving so satisfactory in India, is becoming imitated more or less in various parts of the world. In the Vilayet of Trebizond the virgin forests cover an area of 1,000 square miles, one half of which belongs to the crown, and the other half, which consists mainly of groves, situated in the vicinity of villages, is considered by the inhabitants as belonging to the commons, and in a few cases to private individuals. Most of the crown forests are in the districts of Livanah, Adjarah, Batoom, Tsorook Soo, and Off on the east; of Trebizond, Ordoo, Guerela, and Aktshe Abad on the west; and Madjka, Kurtine, Kelkit, and Shagran on the south. In these forests the pitch-pine, fir, ordinary pine, and beech predominate. Chestnut, alder, elm, oak, ash, maple, and lime are also everywhere and in great numbers. Boxwood grows especially at Atina and Rijah, and the juniper at Kerasond, Tinebali, and Livanah. The mean distance of the forests from the sea-shore is about fifteen miles. Although in general the means of transport are wanting, there are many forests that can be worked with comparatively small outlays for the construction of short roads, in consequence of the proximity to the existing high roads, such as the forests of Kerasond and Madjka, or to rivers on which the timber can be floated, such as the forests of Livanah and Sireboli. With the exception, however, of boxwood, exported from Kiyeh and Atinah, and a little timber from Batoom, no advantage is derived at present from the extensive forests belonging to the crown. The timber and fire-wood used for local consumption is usually cut in the groves situated at no great distance from the sea-shore, or near the villages, and which are claimed by the inhabitants as belonging to them. In consequence of these woods having been constantly and indiscriminately felled, and often burnt down for the purpose of obtaining arable land, they are in a very poor condition. Of late, however, to prevent this destruction, forest guards have been appointed under the orders of special officers.

THE Paris observatory has been opened again to public inspection, on Thursday evenings. Applications must be made by letter to the Secretary.

SIGNOR D'ALBERTIS left Somerset, in York Peninsula, on May 18th last, on his exploring expedition to New Guinea.

He anchored at Harvey's Reef on the same night and left for Long Island on the following morning. Writing on May 21st, he hoped to be in the Fly River in two days more. He has obtained a parrot which he thinks is new—an *Eclectus*. In the July number of the *Melbourne Review*, an article by Dr. G. Bennett contains a life of Signor D'Albertis, together with an account of his journey to the Arfak Mountains.

IT will interest zoologists to know that living specimens of the fish *Ceratodus* have been received at Sydney from Maryborough, in Queensland, and that there is some prospect of their reaching the Zoological Society's Gardens in Regent's Park.

DR. MIKLUCHO MACLAY, the Russian naturalist, is returning to his old field of scientific research in Astrolabe Bay, on the north-east coast of New Guinea, and he desires that passing ships should give him a call.

A CORRESPONDENT of the *Times* describes two thoroughly prehistoric spectacles which he witnessed in Fiji. One was a young girl dressed in two yards of calico print and a girdle of leaves, breaking "ivi" nuts—a kind of large coarse chestnut with a hard shell—with a genuine stone adze, fixed to its wooden handle by coils of plaited string. The other was a little shrivelled old woman, who was making an earthenware vessel, nearly as large as herself, with no other implements than a round flattened pebble about four inches in diameter, and a piece of wood about as large as the back of an ordinary hair brush, slightly concave on the surface. Dipping both stone and wood frequently in water she moulded the inside of the huge pot with the former, and patted the outside into shape simultaneously with the latter. The vessel was egg-shaped, the opening being at the top or large end of the egg with an everted lip. It was nearly three feet in height and two in diameter, and was formed of clay found near the village. When it is complete a fire is built round it on the ground, and it is carefully baked before being removed. In the houses these pots are placed on their side with the mouth inclined slightly upwards, and are seldom exposed to the risk of breakage by removal from their side. They are, of course, very fragile, but in the hands of the natives they are said to last for years.

THE International Geographical Congress at Brussels, which concluded its labours last Thursday, has drawn up a programme relative to African exploration, in which it is recognised as necessary that stations should be established for the purpose of furnishing travellers with the means of existence. An international committee and branch committees in each country are to be appointed. The International Executive Committee will be composed of Sir Bartle Frere, Dr. Nachtigal, and M. Quatrefages, and will be presided over for the first year by the King of the Belgians, with the idea of allowing the presidency to pass successively to distinguished personages of other countries.

THE *Boston Medical and Surgical Journal* contains a short account of the late distinguished naturalist, Christian Gottfried Ehrenberg, whose death we announced last week. Born in 1795, at Delitzsch, he commenced the study of theology at Leipsic when twenty years of age. In 1817 he matriculated at Berlin, and devoted most of his time to physiological chemistry. Between 1818 and 1820 he spent much time in the study of the fungi. During the five years following he travelled in Egypt and Arabia. In 1829 he accompanied von Humboldt to the Ural Mountains. Between that time and 1834, under the title, "Symbolæ Physicæ," he published contributions to the anatomy and physiology of the lower invertebrata. In 1835 he published a paper on phosphorescence, which he explained as dependent on the presence of infusoria; and shortly afterwards his works on "Infusoria as Perfect Organisms," and "A Glance at the Deeper Life of Organic Nature," appeared. In 1837 he was elected a Fellow of the Royal Society of England, and, in 1842, one of the thirty Knights of the Order of the Friedens Klasse. During the latter part of his life Ehrenberg suffered from cataract, a successful operation for the removal of which he survived but a few weeks.

AT the meeting of the Academy of Medicine in Paris, on August 8, M. Broca read a memoir on cerebral topography, in which, among other points, he showed that Gratiolet was misled in supposing that the fissure of Rolando coincides with the coronal suture of the skull. M. Broca seems to be unacquainted with Prof. Turner's investigations in this direction, which demonstrate that the fissure of Rolando lies as much as 1½ or 2 inches behind the coronal suture.

IN a paper of considerable interest in the *Journal of the Asiatic Society of Bengal*, vol. xlv. part 2, 1876, on protracted irregularities of atmospheric pressure, and their relation to variations of the local rainfall, Mr. H. F. Blanford is led to conclude that the distribution of pressure in India is subject to protracted local variations, which are nevertheless not permanent, and that these irregularities of pressure probably explain the irregularities of the rainfall. The former of these may almost be regarded as an established fact in Indian meteorology, while the latter can as yet be regarded as only probable. For the elucidation of this highly practical and scientific question, longer continued observations, and observations embracing a wider extent of the monsoon region, are required than are yet available.

WE have on our table the following books:—"Field Geology," W. H. Penning (Baillière, Tindall, and Cox). "Central Africa," Col. C. Chaillé Long (Sampson Low and Co.). "Electro-Telegraphy," F. S. Beechey (Spon). "The Theory of Sound and its Relation to Music," Prof. Pietro Blaserna (International Scientific Series: H. S. King and Co.). "Catalogue of the Western Scottish Fossils" (Blackie and Son). "Notes on the Fauna and Flora of the West of Scotland" (Blackie and Son). "The Principal Manufactures of the West of Scotland" (Blackie and Sons).

ALL the tanks at the Royal Westminster Aquarium are now complete and stocked. It is estimated that the entire exhibition of marine and fresh-water animals embraces no less than fifteen thousand individuals, representing one hundred and thirty-seven distinct varieties. Out of these the class of fishes includes eighty-five species and thirteen thousand specimens. Among the latest arrivals are several examples of the Spanish Bream (*Pagellus erythrinus*), now for the first time exhibited in this country; six specimens of the John Dory (*Zeus faber*), and a shoal of Boarfish (*Capros aper*). The reptilian section has been enriched by a specimen of the true tortoise-shell producing turtle (*Caretta imbricata*). It is proposed shortly to commence a series of popular lectures upon the inhabitants of the tanks.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mr. Meyrick; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. Edward Soy; a Black-eared Marmoset (*Hapale penicillata*) from south-east Brazil, presented by Miss Woellwarth; a Coati (*Nasua nasica*) from South America, presented by Dr. C. R. Bree; a Common Raccoon (*Procyon lotor*) from Central America, presented by Mr. H. B. Whitmarsh; a King Parrakeet (*Aprosmictus scapulatus*) from Australia, presented by Mr. H. T. Sissons; a Rüppell's Spur-winged Goose (*Plectropterus ruppelli*) from East Africa, presented by Mr. M. J. M. Cornely; a Burchell's Zebra (*Equus burchelli*) from South Africa, two Hairy Armadillos (*Dasypus villosus*) from La Plata, deposited; two Russell's Vipers (*Vipera russelli*) born in the Gardens.

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, No. 6, 1876.—From experiments it is here inferred by Dr. Buff, of Giessen, that the heat conductivity of hydrogen and other gases is too small to be demonstrable by the method proposed by Magnus. Hence the supposition of a conductivity similar to that of metals (if aught more is meant, than that hydrogen can, like solid and liquid bodies, transfer heat from molecule to molecule), is unwarranted. On the other hand, hydrogen has a penetrability for heat rays which comes very near that of vacuum. Dry air absorbs 50 to 60 per cent. of heat rays from a source heated to the boiling point of water. The absorptive power of moist air exceeds that of dry air by several percentages, but not nearly so much as has been supposed by some physicists. Rock salt is not perfectly diathermanous to so-called obscure heat rays. Its "heat colour" is rather like that of dry air.—Dr. H. C. Vogel describes some interesting experiments on change in pitch of tone of a moving body; they consisted in observation of the whistle of a locomotive, and the results closely agree with Doppler's theory and calculations.—M. Wiedemann's paper on the laws of passage of electricity through gases is here concluded. The experiments relate to difference of effect according as positive or negative electrode (in the discharge apparatus) is connected to earth, effect of varying length and width of tube between the electrodes, also of varying pressure and gas, the rise of temperature produced by the discharge, effect of heating electrodes, &c. The view M. Wiedemann adopts is, that in discharge, the gas molecules on the electrodes carry off electricity with them, and impart it to others against which they are driven, and these in their turn are impelled against a third set, and so on; the case being similar to that of a row of freely suspended elastic balls, one of the end ones of which is driven against its neighbour. The author further studies the unequal expansion of the positive and negative discharge, the place where the *vis viva* of the moved gas masses is finally transformed into heat, the dark space at the negative electrode and the stratification of the light, and points out the relation in which his results stand to those obtained by Hittorf.—The constants of dielectricity of oil of turpentine, benzol, and two varieties of petroleum, are determined by M. Silow, by the condenser method, and their square roots are shown to correspond closely to the refractive indices of the liquids, with $\lambda = \infty$ (according to Maxwell's law).—Some anomalous phenomena of the gold-leaf electroscope are pointed out by M. Beetz (they indicate a streaming out of electricity from the leaves over the glass).—We note, lastly, a paper of contributions from the Mineralogical Institute of Strasburg University, referring to glaucophane, datolith, safrol, crystalline form and optical properties of isomerous dinitro benzol, &c.

Journal of the Chemical Society, June.—This number contains an extensive and exceedingly interesting paper on some points in the analysis of potable waters, by Prof. Frankland, D.C.L., F.R.S. Some eight years since, Dr. Frankland, in conjunction with Dr. Armstrong, laid before the Fellows of the Chemical Society an account of the observations and experiments made by them during two years on the methods then employed in the analysis of potable waters. During the time which has elapsed since that occasion Dr. Frankland has adopted the combustion and collateral processes then recommended, and nearly nine years' further experience in water analysis induce him to claim for this process the following recommendations:—1. It is the only process which affords trustworthy information respecting the organic matters present in potable water. 2. It alone professes to determine organic carbon in such waters. 3. Its method of determining organic carbon and nitrogen gives fairly accurate results, even in the hands of a comparatively inexperienced analyst. 4. It alone discloses the proportion of nitrogen to carbon in the organic matter of waters. 5. The process can now be conducted in any laboratory with little difficulty, owing to the modifications in the method of evaporation which have been made.—Mr. W. H. Perkin, F.R.S., contributes a paper upon the formation of anthrapurpurin.—Dr. Thorpe, F.R.S., communicates some notes from the laboratory of the Yorkshire College of Science, Leeds, comprising a short paper by Herbert Eccles on the action of the copper-zinc couple on potassium chlorate and perchlorate, one by John Muir on thallium chlorate, and a third by Dr. Thorpe himself, on the isometric relations of thallium. As usual the remainder of this volume contains numerous abstracts of chemical papers published in British and foreign journals.

The *Jahresbericht*, 1874-5, of the Swiss *Naturforschende Gesellschaft*, contains a lengthy account of this Society's last annual meeting, held at Andermatt in September 1875. The opening speech was delivered by Prof. Kaufmann, the president, and mainly of geological interest. Amongst a number of smaller papers that were read we note the following more important ones: On the observations of temperature made in the St. Gotthard tunnel; the temperatures of air, water, and of the soil were registered at a great number of different places in the tunnel, as far as it is constructed, both on the north and south sides, by Dr. Stapff.—On the so-called "seiches," oscillation waves observed in Swiss lakes, principally Lake Leman, by Dr. Forel.—On the recent appearance and the damage done by locusts in the east Swiss Rhine districts, and on the banks of the Bieler Lake, by Prof. C. G. Brügger and Alb. Müller.—The other papers are of minor interest.

SOCIETIES AND ACADEMIES

New South Wales

Royal Society, May 17.—Rev. W. B. Clarke, M.A., F.G.S., in the chair.—The officers for the ensuing year were balloted for:—President (*ex-officio*), the Governor, Sir Hercules Robinson, K.C.M.G., &c.; Vice-presidents, the Rev. W. B. Clarke, M.A., F.G.S., Mr. H. C. Russell, F.R.A.S., Government Astronomer; Hon. Secretaries, Prof. Liversidge, Dr. Leibius. The treasurer presented his annual statement, which showed that although the Society had expended a considerable sum during the past year upon furniture and fittings for the new rooms, there was still a very satisfactory cash balance. The Rev. W. B. Clarke then delivered his annual address. The Society was informed that sections were about to be established by the council in order that members who devoted themselves to particular branches of scientific study might have afforded to them more frequent opportunities for meeting and working together than was possible at the more formal general meetings of the Society.

June 7.—The Rev. W. B. Clarke, F.R.S., in the chair.—The chairman stated that the deputation appointed for the purpose at a former meeting, had waited on the Minister for Justice and Public Instruction and had submitted a request to be communicated to the Government for the sum of 3,500*l*. for the erection of a suitable building and 300*l*. annuity for the ordinary purposes of the Society. They were courteously received, and the Minister cordially promised to lay the matter before his colleagues.—Prof. Liversidge, hon. secretary, announced that a large number of members had entered their names for the sections, and gave notice that arrangements had been made for the preliminary meetings of the following sections, viz.:—Section A. Astronomical and Physical Science. B. Chemistry and Mineralogy. C. Geology and Palæontology. D. Biology. E. Microscopical Science. F. Geography and Ethnology. G. Literature and Fine Arts. H. Medical Science. I. Sanitary and Social Science and Statistics. It was mentioned that a large number of gentlemen interested in scientific matters were desirous to be elected into the Society as soon as the above sections were established.—Mr. H. C. Russell, F.R.A.S., Government Astronomer, then read a paper entitled, "Notes upon some Remarkable Errors in Thermometers," which had been exhibited by standard instruments at the observatory. He also exhibited an improved form of heliostat suitable for signalling purposes.

Gottingen

Royal Academy of Sciences, March 4.—The following, among other papers, were read:—Some important improvements in simple and compound influence-machines, by M. Holtz.—On the constitution of steel and its connection with magnetisability, by M. Fromme. He credits M. Ruths with the true settlement of this question. With small magnetising forces an annealed bar always takes more magnetism than a similar hardened bar. But as the magnetism in the hardened bars increases in greater ratio than in annealed bars, a value of magnetising force is reached, at which the magnetism of the hardened bar reaches that of the annealed, thereafter exceeding it. This indifferent force is smaller the thicker the bar in comparison to its length. With a certain ratio of length and thickness it becomes infinitely great. The contradictions of previous observers are explained when dimensions are taken into account. M. Fromme, using more adequate means, confirmed M. Ruths' results. M. Gaugain has recently got results that fully agree with those of Ruths; but M. Fromme explains them somewhat differently from the French physicist.

April 12.—Contribution to anatomy of the medullated peripheral nerve fibres, by M. Kuhnt.

May 6.—On the conductivity of electrolytes dissolved in water, in connection with the wandering of their constituents, by M. Kohlrausch. The conductivities of electro-chemically equivalent solutions of two electrolytes which have one constituent in common, are inversely as the transference-numbers of the same equivalent; or the product of the conductivity of the solution and the transference number of the common constituent on both sides is the same. The hindrances to movement in dense solutions, it is found, generally affect the kation more than the anion.—On the movement of electricity in material conductors, especially in a conducting ball, by M. Riecke.—Sulphide of carbon as a preserving and disinfecting substance, by M. Zoeller.—On the pressure forces arising from simultaneous motions associated with contractions and dilatations of several spherical bodies in an incompressible liquid, by M. Bjerknes.

June 17.—Theory of unipolar induction and Plücker's experiments, by M. Riecke. He considers first, the induction of a moved magnetic pole on a linear conductor at rest; then the induction of a magnetic pole at rest on a rotating conductor; then applies the principles arrived at to Plucker's experiments; a fourth chapter is on Wilhelm Weber's unipolar induction.—Contributions to anatomy of the Crinoideæ (second article), by M. Ludwig.—Physiology and histology of the central nerve-system of helix pomatia, by M. v. Ihering.—Sulphide of carbon as a preserving substance (second paper), by M. Zoeller. Five drops of the liquid to a litre of air space suffices to preserve the most decomposable fruits and vegetables. These tasted quite fresh after short exposure to the air, and meat quite lost the smell of sulphide of carbon after boiling or roasting, but it had a slight flavour like that of game, which, to most people, is not unpleasant. It appears that sulphide of carbon acts in the way of coagulating albuminous substances and lessens the water-contents of the preserved substances.

VIENNA

Imperial Academy of Sciences, July 6.—On the causes of keratitis after section of the trigeminus, by Dr. Feuer.—Experiments on the heat conductivity of nitrogen, binoxide of nitrogen, ammonia, and coal-gas, by M. Plank. These are, respectively (the conductivity of air being made = 1), 0·993, 0·951, 0·917, 2·670.—Studies on the more recent tertiary formations of Greenland, by M. Fuchs. Several new fossil species are described.

July 13.—Action of current electricity on the motion of protoplasm, on living and dead cell contents, and on material particles generally. Second part: Influence of the galvanic current on dead cell contents; by M. Velten. Very strong induction currents sent through a cell, or a number of cells, set the contents in rotation, which is very like vital rotation, and follows the same laws. The botanical phenomena of circulation, sliding motion, &c., can be well imitated by this means. M. Velten infers that the cause of protoplasm-motions is to be sought in electric currents produced in the living cell contents.—On the advancement of science by professors and private *savans*, the doctrine of geognostic land-types, and the method of geological surmises *à priori*, by M. Boué.—On some elementary infinite series, by M. Igel.

PARIS

Academy of Sciences, Sept. 4.—Vice-Admiral Paris in the chair.—The following papers were read:—New theorems relative to couples of segments making a constant length, by M. Chasles.—Researches on the disappearance of ammonia contained in waters (first part), by M. Houzeau. Water from wells quickly loses its ammoniacal principle in a vessel hermetically sealed. Light favours this disappearance, but is not indispensable to the phenomenon. This suggests the practical process of exposure to the sun. M. Houzeau also found that artificial ammonia added to water (in the form of carbonate of ammonia) quickly disappeared.—Representation of elliptical functions of the first species by means of left biquadratics. Extract from memoir by M. Léauté.—Rectification of a previous communication on determination by the principle of geometrical correspondence, of the order of a geometrical place defined by algebraic conditions, by M. Saltel.—Results obtained by means of new apparatus for extraction of the juices of sugar-cane, by MM. Mignon and Rouart. The plan they have adopted (in Guadaloupe) is partly like that in treatment of beet. They use a rasp or defibrating machine; this process reaches the hardest parts forming the envelope of the cane, and disorganises the cells which are richest in sugar and which most easily escape in the ordinary treatment. In the hydraulic press used, there are two pistons; the smaller gives twelve atmospheres, and acts during the whole of the compression; the action of the larger piston is added, the two together giving a pressure of 80 atmospheres. The results obtained surpass considerably those from ordinary methods. Thus cane simply defibrated and subjected to only one pressure, gave 77 per cent. of its weight of very rich saccharine juice.—On a submarine elevation observed in the Gulf of Arta, by M. de Cigalla. In 1847 and 1865, after some shocks of earthquake, a very dense sulphurous vapour rose from the bottom and destroyed many fishes (such emanations still occur, but less in quantity). The hydrographic maps for 1847 gave 8 fathoms as the depth there. Now recent soundings show that the bottom has risen, forming a cone 300 fathoms in circumference, and with its summit of 2 fathoms 4 feet under the surface. The temperature of the water is not sensibly altered. Objects kept in the water a few days are covered with a light coat of sulphur. The raised ground consists of very small shells, while the neighbouring bottom is of oozy nature.—Observation of American vines attacked by phylloxera, in the environs of Stuttgardt, by M. Schnetzler. Three centres of invasion were discovered in July. The vines infested are all of American origin, and were imported twelve or thirteen years ago, either directly from America, or from France. The insect attacks the roots and rootlets.—Observations of the planet 166, by Mr. Peters.—Discovery of planet 167,—dispatch transmitted on Aug. 29, 1876, by Mr. Joseph Henry, of Washington. The planet was discovered by Mr. Peters of Clinton.—On the characteristics of conical systems, by M. Halphen.—New theory of the numbers of Bernoulli and Euler, by M. Lucas.—On the invention of the pneumatic fire-syringe, by M. Govi. From the *Giornale dei Letterati*, published in Rome about the middle of the eighteenth century, it is shown that the pneumatic fire-syringe, which has been thought to date from 1862 or 1863, was invented and described in 1745 by the Abbé Augustin Ruffo, of Verona, more than half a century before a workman of St. Etienne gave the idea of it to Prof. Mollet, of Lyon, or M. Fletcher experimented with it before Mr. Nicholson.—On the dissociation of bicarbonate of soda at the temperature of 100°, reply to M. Gautier, by M. Urbain. M. Gautier, heating 4 grammes of dry bicarbonate of soda between 100° and 115°, found it completely decomposed in eighteen hours; he infers that in dried blood-plasma, thus heated, the bicarbonate of soda must also be decomposed. M. Urbain denies the inference, because in the latter case the salt is empasted in a substance which forms a varnish round each of its fragments, and this corresponds to the case of heating the salt in a closed vessel, when dissociation does not occur.—Note on the phenomena of digestion in the American Cockroach (*Periplaneta americana*, L.), by M. Plateau. His examination of this insect confirms his former observations, from which he concluded that the digestive juices of insects are alkaline or neutral, never acid.—Researches on the silicified plants of Autun and Saint Etienne; Calamodendreæ and their probable botanical affinities, by M. Renault. Several resemblances seem to favour the supposition that Calamodendreæ have been the ancestors of the present Gnetaceæ.

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THURSDAY, SEPTEMBER 28, 1876

THE INTRA-MERCURIAL PLANET OR PLANETS

THE question of the existence of one or more planetary bodies revolving *within* the orbit of Mercury is again revived by Weber's observation of a round black spot just within the sun's eastern limb, on the afternoon of April 4 in the present year which had not been visible on the same morning, and early on the following day had disappeared. The position at 2¾' only from this limb is one, where an ordinary spot would not be expected to exhibit a circular outline; and a round black disk, in such a position more especially, must instantly attract the attention of a practised observer. On April 4 clouds unfortunately prevented lengthened observation, and in Weber's notice there is no reference to any perceptible motion during the short time the spot could be watched.

This observation resembles others already upon record, made by persons equally worthy of credit, which it is hardly possible to explain except on the hypothesis that one or more planetary bodies exist with mean distance less than Mercury, the rate of motion where motion has been detected by the most reliable observers, not being consistent with greater distance from the sun. While it is certain that comets with perihelia within the earth's orbit have transited the solar disk, and notwithstanding such transits may have been more frequent than is generally supposed, the appearance of the spots now in question seems, at least in several of the best authenticated cases, to negative any idea of their being due to the passage of comets across the sun, near their nodes. At the same time there are several instances where the form of the spots would perhaps accord better with the assumption of a cometary transit, unless we can admit that the deviation from circular contour is attributable to an optical cause.

It may be remembered that the attention of astronomers was first seriously directed to the possible existence of a planet or planets interior to the orbit of Mercury, by M. Leverrier's announcement that the motion of the perihelion of this planet was not explained by known causes of perturbation, but that an excess of 38 seconds in the century must be admitted beyond the value derived from theory, to produce an agreement between calculation and observation in the discussion of the long series of observed transits across the sun's disk. The unexplained motion of the line of apsides might, as M. Leverrier remarked, be due to the existence of a single interior planet of a mass which would depend upon its mean distance. With a distance of 0·17 (period of revolution, 25·6 days) the mass would be precisely equal to that of Mercury, and it would vary inversely with the distance. Or it might be due to a group of small planets circulating within the orbit of Mercury.

Having before us the whole of the recorded observations of the presence of suspicious spots upon the sun's disk, we shall soon discover that they hardly admit of explanation on the hypothesis of a single planet, even if we assume a small inclination of the orbit of this planet to the ecliptic, a condition which, while it would greatly extend the transit-limits, must at the same time render the transits so frequent that it is in a high degree improbable the planet could have so long escaped certain detection. Some few of the observations, as just remarked, we may perhaps refer to comets in transit; it remains to endeavour to ascertain from observations not thus explained what period or periods will best represent them, with the view to being warned of the probable times of future transits.

This subject has engaged the attention of M. Leverrier during the last few weeks, or since he became cognisant of Weber's observation last April, the notification of which was long delayed. It appears that the observations of Stark and Steinheibel, 1820, February 12, Lescarbault, 1859, March 26, and that of Weber, may refer to the same planetary body if the revolution be supposed 28·0077 days; this being the sidereal revolution with respect to the node, the synodical period would be 30·33 days; the corresponding mean distance from the sun is 0·18, and the maximum elongation 10½ degrees. Such a planet would again be in conjunction with the sun on October 2nd or 3rd of the present year; and if Lescarbault's observation affords any approximation to the position of the line of nodes would pass across the sun's disk, and for this reason M. Leverrier has directed attention to the importance of a close watch upon the same, during these days, such watch, if possible, to extend to distant meridians, so as to insure pretty continuous observation through the forty-eight hours, Paris time. He has already advised American observatories through Prof Henry, Secretary of the Smithsonian Institution, and it is to be hoped the chance of making an important discovery at this time, may be made known to observers in the East. It will be seen that the aid of the telegraph is indispensable, in order to secure complete evidence of the existence or non-existence of the hypothetical planet this autumn.

Other observations may be reconciled with a period of similar length, but the planet to which they may be supposed to refer cannot be identical with the above. Thus if Mr. Lummis's sketch of the path of the small round black spot, which he remarked upon the sun at Manchester on the morning of March 20, 1862, is reliable in the hurried and otherwise disadvantageous circumstances under which it was made, the ascending node was almost diametrically opposite to that of Lescarbault's planet, elements which have been attributed to MM. Valz and Rádau, and exhibiting a near agreement in the position of the line of nodes, being certainly erroneous. Again, one of the most interesting observations bearing upon the existence of an intra-mercurial planet is that made about the end of June or beginning of July 1847 in this country, which can hardly be supposed to refer to either of the objects seen by Lescarbault and Lummis respectively. The exact date of this observation is unfortunately lost beyond recovery.

Mr. B. Scott, the City Chamberlain, observing the sun's disk near London, a short time before sunset late in June or on one of the first days in July, remarked upon it a perfectly circular black disk, and was so confident of the unusual character of the spot that he was on the point of making known his observation through one of the London daily journals on the evening of the same day, when unfortunately an astronomical friend, under the impression that an ordinary spot had been observed, dissuaded Mr. Scott

from so doing. It thus happened that the matter dropped until the announcement in 1860 of Lescarbault's observation on March 26 in the preceding year, when Mr. Scott, in a communication addressed to the *Times*, drew attention to his experience in the summer of 1847. It was then discovered that he had not been the only observer of the strange object. Mr. Wray, the well-known optician, then resident at Whitby, had remarked a small circular black spot upon the sun late one afternoon at the end of June or early in July, though he also had, in 1860, lost the exact date. Both these gentlemen have furnished the writer with every other particular of their observations. That they refer to the same object can hardly be doubted. Mr. Wray had it under observation for forty minutes, when the sun sank into a bank of cloud and was not again visible that day. In this interval the spot appeared to have moved about five minutes of arc, and when last perceived was so near the western limb of the sun that Mr. Wray believes if the cloud had not interfered, in about ten minutes he would have witnessed the egress. This circular spot, the diameter of which he judged to be about six seconds of arc, was not visible early on the following morning, though other spots of ordinary form which were present on the disk remained nearly unchanged. Mr. Scott was observing with a refractor of about 4½ inches aperture, Mr. Wray with a fine 6-feet Newtonian reflector of equal aperture, which he was employing at the time in a study of the varying aspect of the solar spots. Notwithstanding the unfortunate loss of the date of these observations, such particulars as are available are still of value as certifying the existence of such objects in transit; there is no observation of the kind resting upon more excellent authority.

A letter from Prof. Heis, of Munster, the author of the "Atlas Cælestis Nova," received while closing these remarks, gives full details respecting Weber's observation. The spot was intensely black, perfectly round, and smaller than the planet Mercury in transit. Prof. Heis expresses the utmost confidence in this observation by his friend, who has long been accustomed to examine the solar disk. J. R. HIND

UNIVERSITY COLLEGE, BRISTOL

WE have been able to keep our readers informed of the various steps which have been taken to bring to fruition the movement which was commenced about three years ago to establish in Bristol an institution for University education. This movement, we are glad to say, has been so far successful that a beginning is to be made on Tuesday week, October 10; on that day commences the first term of the first session of what will be henceforth known as University College, Bristol. From the first it was sought to make the proposed institution something more than a mere "technical" college. All along it has been kept in view that the only really liberal training is one in which all the faculties of man are drawn out harmoniously and equally, in which a broad basis for future special work is laid, by education in all the great departments of human knowledge. The Bristol institution is not to be a mere special college, it is to be a University. Prof. Jowett, at the meeting held in June, 1874, struck the right note when he said: "The distinction he would draw between liberal education and merely technical education was this—the one comprehended the other; it was the other, with something added to it, carried on in a higher spirit; it was the one pursued not merely for the sake of getting on in the profession, or making a man an engineer, or a miner, or a doctor, but for the sake of the improvement of the mind. No man will be a first-rate physician or engineer who is not something more than either." The first programme of the classes of this new college is certainly a modest one so far as extent is concerned, but it comprehends all the elements of a liberal education—literature, science, and art. In science there will be instruction in chemistry, physics, zoology, botany, geology, mathematics and applied mechanics, and political economy; in literature, classes for modern history and literature; and in art (for evening classes at least) geometrical and mechanical drawing. In all these branches professors or lecturers have already been appointed, but the programme contains other subjects—classical languages and literature, modern languages, and textile industries—to which no appointments have yet been made, but which will no doubt be filled up as soon as circumstances permit. Affiliated to the Bristol College, moreover, is the old-established Bristol Medical School, for which new buildings will be erected, and on which, we believe, the new institution will have a stimulating and liberalising effect. The principal work of the college will of course be carried on during the day by means of lectures and laboratory work, but we are also glad to see that the directors have resolved to follow from the first the excellent example of Owens College, Manchester, by establishing evening classes for those who are unable to take advantage of the day classes.

Altogether the originators of this movement and the Council of the College are to be congratulated on the fair start they have made, and if they continue as they have begun, we cannot doubt that in no long time University College, Bristol, will become as great and as firmly-established a centre of culture as the Owens College, Manchester. But in the meantime the great want of the new institution is money. Owens College, Manchester, has received many liberal donations since John Owens left his 100,000*l*. for the endowment of professorships, and by these gifts it has been enabled to develop wonderfully. But even Owens College feels itself hampered from want of sufficient funds, and now with justice advances its claims to government endowment. The originators of the movement which has just reached a successful culmination in Bristol calculated that they could not make a beginning without a capital sum of 25,000*l*., and an annua subscription of 3,000*l*. for five years. They have received many liberal donations and subscriptions, and have obtained so nearly all that they thought was required, that they have felt authorised in making a beginning. From the first Balliol and New Colleges promised 300*l*. a year each for five years. A good many donors, individuals, firms, and companies have given 1,000*l*. each, and many subscriptions of smaller sums have poured in. The Clothworkers Company have offered a handsome subscription, on condition that means are taken to promote technical education in the West of England clothmaking districts, and as we have said, "Textile Industries" is put down as one of the lectureships to be filled up. We hope, however,

that the Worshipful Company will not put too narrow a construction on the conditions of their subscription, but that they will have the shrewdness to see that the best possible preparation for a special knowledge of textile industries is a thorough grounding in the sciences on which these are founded.

Still, notwithstanding all that has been done and promised, the Bristol College must stand still, and therefore fail of its purpose, unless subscriptions and endowments continue to pour in handsomely until it be enabled to offer an education not inferior to that offered by Owens College, Manchester, or the Universities of Edinburgh and Glasgow. We feel confident, however, that once the institution is fairly started and at work, and has had opportunity of showing the vast benefits it is able to confer on the large industrial population with which it is surrounded, and thus indirectly on the general culture and material welfare of England, that some at least of the many rich and liberal-minded men in the country, who only wait for a worthy object on which to exercise their generosity, will see that here is one that deserves and requires their help, by giving which liberally they will not only benefit their country but do lasting honour to themselves. No similar institution that has been started on a liberal and disinterested basis and has been properly brought before the public has yet proved a failure; we need only refer again to Owens College, to the Newcastle College, and to the more recent Yorkshire College of Science, which, however, has much to do before it gets beyond the stage of a merely technical school. Soon also will we have an institution in Birmingham, the Josiah Mason College, so liberally endowed by its still living founder. These institutions have all sprung up to supply what was felt as a great want; and no district in the country has more need of a centre of liberal culture than the south-west of England, the seat of so many and so varied industries. We venture to think that all that has been yet obtained is nothing to what the extensive district, containing so many rich landed proprietors, manufacturers, and merchants, can afford. Now that they see the institution actually at work in their midst, and perceive how impossible it is for it to do efficient work on its present basis, we cannot doubt that they will extend their liberality, and, aided by others throughout the country who are able and always ready to help in a noble and deserving cause, establish University College, Bristol, on as solid a pecuniary foundation as any similar institution in the country.

We need not insist here again, as we have often done already, on the fact that we are in danger of losing our lead among the nations so far as industry is concerned, from th eficient training of those who have the conduct of our commerce and manufactures in their hands. It is a fact which is being ever and anon reiterated on the platform and by the general press. Along with a sound and comprehensive system of elementary education, it is only by establishing all over the country, in the great centres of industry, institutions where a comprehensive education can be obtained as the only satisfactory basis on which a special training can be built, that we shall be able to hold our own on the Continent and with America. We have five such centres in England either established or about to be, some of them, however, greatly deficient in comprehensiveness. Bristol, we have no doubt, will one day become one of the most efficient in the country. Everything has gone smoothly hitherto. Even the Clifton Association for the Higher Education of Women intend to have no courses of lectures this winter, to see how far women in and around Bristol will avail themselves of the College; for the lectures will be given to both sexes at once, though the class instruction will be separate. We only hope that other important centres will follow the examples already set, and that ere many years no man in England will have to go without a liberal education because it is not within his reach. If Scotland with her four millions of people finds it difficult to meet her wants in this direction with four universities, how much has yet to be done in England with her twenty-four millions ere she is on the footing of even her poor relation of the north.

FIELD GEOLOGY

Field Geology. By W. Henry Penning, F.G.S., Geologist, H.M. Geological Survey of England and Wales. With a Section on Palæontology, by A. J. Jukes-Browne, B.A. F.G.S., H.M. Geological Survey. (London: Baillière, Tyndall, and Cox, 1876.)

IN the modestly-written preface to this little volume, the author naturally refers to the difficulty which he experienced in determining what subjects ought properly to be treated under the title of "Field Geology." It would have been defensible to have included in such a work as the present useful, if somewhat desultory, suggestions upon almost every branch of geological inquiry, and thus to have expanded the convenient manual into a ponderous treatise; we believe, however, that the author has exercised a very wise discretion in restricting the work within its present limits, and making it of as practical a character as possible; for everything calculated to increase the size, weight, and price of the book must, perforce, have tended to prevent it from occupying that place for which it is primarily designed—the portmanteau of the working geologist.

The Geological Survey of the British Islands, the foundation of which was laid by the labours of De la Beche and Logan nearly half a century ago, and which is now approaching completion, differs in some important respects from most of the official geological surveys of European and American states. While the latter usually aim at little if anything more than defining the boundaries of the areas occupied by each of the geological formations, the former sets before itself a much more lofty ideal—no less in fact than such a delineation of all the lines of outcrop of the strata, with indications of their flexures and dislocations, as will enable any competent person using the maps and sections to realise the actual geological configuration of the rock-masses to a considerable depth below the surface.

Of course the execution of such a design as this must necessarily be very unequal. Not to mention differences of individual ability and scientific culture in the members of the staff of the survey—differences, the consequences of which not even the most perfect organisation or rigid supervision can altogether neutralise—we must remember that the data on which the geological surveyor has to rely n drawing his lines in different areas, are so varied as greatly to affect the value of the results attained. In one sheet of the Geological Survey map, which happens to

represent a district free from superficial accumulations, and in which numerous alternations of hard and soft beds afford the greatest facilities in detecting every deviation of the strata from their normal position, the minute structure of the country will be found delineated in the most exquisite detail; while in an adjoining sheet broad spreads of colour separated by dotted lines constitute a confession that the surveyor was here engaged in an almost hopeless task. It may, indeed, be questioned whether on a map of so large a scale as that of the Geological Survey, any useful purpose is answered by attempts to define the boundaries of formations buried under several hundreds of feet of boulder-clay or gravel. Another serious obstacle to the perfecting of our geological maps is found in the circumstance that rocks of identical mineralogical composition, but of very different geological age, are found occasionally in direct apposition; and in such cases (except in the rare instances of numerous sections affording fossils characteristic of either formation presenting themselves) the field-geologist finds himself hopelessly at fault. For example, in those parts of England in which the limestones and grits of the Coralline Oolite are found intervening between the Oxford and Kimmeridge clays the work of the surveyor is an easy one; but where, as is frequently the case, the first-mentioned formation is absent and the one series of argillaceous strata lies directly upon the other, the result attained by him is necessarily of the most vague and uncertain character. On the other hand, many of the hard and well marked rock-masses, which the geological surveyor naturally seizes upon in drawing his lines of boundary, are too frequently, alas, shown by the palæontologist to be altogether destitute of any important significance.

In spite, however, of these unavoidable inequalities and imperfections in its execution, the map of the Geological Survey is a splendid work, and one of which the country may justly be proud; it has already largely prevented the wasteful expenditure of the resources of the empire in futile undertakings, while it has brought to light many unsuspected sources of mineral wealth; and it is hard to say whether in the future the aid which it will render to those engaged in scientific research will not outrival that which it now affords to industrial enterprise.

The methods pursued by the Geological Survey of this country, in seeking to realise that ideal to which we have adverted, have been gradually *developed* in the hands of the numerous able observers and sagacious thinkers, who have since its foundation been members of its staff. Hitherto, however, these methods have been handed down by tradition only, and no work has existed to which an outsider or foreigner could refer for an exposition and illustration of them. Hence we gladly hail the appearance of the present work, as satisfying a want which has long been felt and frequently expressed.

In the execution of his task we consider that the author has been on the whole very successful, especially when we remember that the experiment is the first of its kind. His explanations are strikingly clear, simple, and full; indeed, we may perhaps suggest that some of the minute details into which he enters are unnecessary for the class of persons to whom alone the book is likely to be of service—those, namely, who have mastered the elementary principles of geological science. For example, we think that the author might fairly have given his readers credit for sufficient knowledge of plane trigonometry to have enabled them to make use of a very simple formula; and he should therefore, it seems to us, have substituted such a formula, with a table of tangents, for the rule-of-thumb and not very accurate methods for calculating true from apparent dips, given in pp. 42–46. His very minute directions, too, concerning the method of running levels for the purpose of preparing geological sections are, we think, a little out of place here, as they differ in no respect from those in ordinary use among engineers and surveyors, and may be found described in any treatise on land-surveying. On the other hand, his suggestions as to the use of two aneroids, one to be examined every half hour at a fixed station, though correct enough in theory, with other less exact methods applied to running lines of level, are certainly likely to be of little actual value to the geologist; while there is an omission of any reference to the really practicable applications of a single aneroid, when used with Airy's tables, either for calculating approximately the difference of level between two points (*e.g.*, the height of a bed of gravel above the level of the present stream), or in supplementing the data found on a contoured map; neither does our author refer to the use of Abney's level and several other simple contrivances which will be found very useful for the same purpose.

The sections on "Lithology" and "Palæontology" are treated with less diffuseness than those on the preparation of geological maps and sections. In a work of reference like the present we cannot but regard the reduction of the information to a tabular form, wherever this is practicable, as a great convenience; and we commend the adoption of the method in this part of the work. Mr. Jukes-Browne's remarks on the collection, preservation, and determination of fossils are, if not exhaustive, at least very useful and practical; but we can only consider the index of characteristic fossils, as unnecessarily increasing the bulk of the book, for no geologist who is able to determine the species of a fossil is likely to be at any loss as to the geological horizon to which it belongs.

Geological surveying is an art which for its successful performance requires some natural aptitude, a considerable knowledge of the principles and results of geological science, careful training, and much practice. The perusal of Mr. Penning's valuable hand-book will not make a man a geological surveyor, but it may enable him to appreciate some of the methods employed in the work—at least under its simplest conditions—as carried out by our national survey. And he who has mastered these first principles as here set forth will be the better prepared to encounter the more difficult problems which are presented by areas of more complicated geological structure and provided with less perfect topographical maps than our own.

J. W. J.

THE BATS OF ASIA

Monograph of the Asiatic Chiroptera. By G. E. Dobson M.A., M.B. (Printed by order of the Trustees of the Indian Museum, 1876.)

BIOLOGISTS have, during the last few years, learnt with interest many of the valuable facts brough forward by Mr. Dobson, of Netley, with reference to th

anatomy and classification of the bats of Asia. The author tells us in the work under notice, which is the summary of the results of his investigation, that he was led to the special study of the Chiroptera from a desire to write a descriptive catalogue of the species of bats preserved in the Indian Museum at Calcutta. Finding, however, that but few species were not therein contained, the author, much to the advantage of his fellow-zoologists, determined to incorporate an account of all the Asiatic forms, the result being that he has presented us with a complete Monograph of the Asiatic Chiroptera.

Further, there being but four species of bats found in Europe which are not also Asiatic, these are also described in footnotes, which still further increases the value of the volume, making it, in fact, a monograph of the Asiatic and European Chiroptera.

There are a hundred woodcuts, mostly original illustrating the configuration of the head and nasal appendages of the most characteristic of the 122 species described; and the work in its letterpress and size corresponds with the valuable catalogues of the zoological collections in the British Museum.

Mr. Dobson divides the order primarily into the Megachiroptera and Microchiroptera, these sub-orders corresponding to the Frugivorous and Insectivorous Bats as usually described. The former of them are arranged in two groups—the Pteropi, with the tongue short and the molar teeth well developed; and the Macroglossi, with lengthy tongues and molars scarcely elevated above the gums.

With reference to the Microchiroptera two branches are assumed to have diverged from the ancestral forms (Palæochiroptera) of the order; one of these, the Vespertilionine Alliance, includes the Vespertilionidæ, Nycteridæ, and Rhinolophidæ; the other, the Emballonurine Alliance, the Emballonuridæ and Phyllostomidæ. This important division is shown to be based upon several well-marked anatomical characters, the members of the Vespertilionine Alliance having the tail always contained within the interfemoral membrane, which it never perforates; the first phalanx of the middle finger extended, during repose, in a line with the metacarpal bone; the premaxillary bones rudimentary, and consequently the incisors small; and the hair scales imbricated, the tips of the scales being arranged in an oblique line, not terminating in acute projections. In the members of the Emballonurine Alliance, on the other hand, the tail, if present, generally perforates the interfemoral membrane; the first phalanx of the middle finger is more or less completely folded forwards, during repose, upon the superior or inferior surface of the metacarpal bone; the premaxillæ with the incisor teeth are large; and the hair-scales are arranged in a transverse series, the tips of the scales nearly always terminating in acute projections.

The character of the hair-scales is one which Mr. Dobson has investigated with special care, and he has submitted his specimens—from more than forty genera—to the inspection of Dr. J. D. Macdonald, who has confirmed his generalisation, except with reference to *Miniopterus* and *Mystacina*, the one otherwise recognisable as an intermediate form, and the other quite peculiar as far as its hair is concerned.

Although the Fruit-bats are included in a separate sub-order, in other words, though they are assumed to have developed "from a group of Palæochiroptera distinct from that from which the Vespertilionine and Emballonurine alliances have sprung," nevertheless, Mr. Dobson considers that they have affinities with that section of the latter group from which the Emballonuridæ are derived This we cannot quite understand. May not the retention of a second index phalanx in *Rhinopoma*, and of well-developed incisors in the Phyllostomidæ be but a want of divergence from the Palæochiropterous type in the branch on which they are placed? a similar absence of modification in the independently-developed Pteropinæ being followed by a similar result as far as structure is concerned. This would, however, have no effect upon the independence of the pedegree-lines of the two groups, and would not make them blend in any parts of their course.

Mr. Dobson lays stress, in his definition of the sub-family Phyllorhininæ on the union of the ilio-pectineal spine with the antero-inferior surface of the ilium, forming a large preacetabular foramen. This unique arrangement, discovered by Mr. Dobson himself, is one which has scarcely attracted the attention of osteologists to the extent which it deserves.

The descriptions of the species are detailed and extremely precise; the synonomy is full, at the same time that the tables of measurements as well as those of specific distinctions will be found invaluable. The work, as a whole, is one of the most important recent additions to zoological literature.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Sun-Spots suspected to be Identical with an Inter-Mercurial Planet

1875, Feb. 22^{d} 0^{h}.—One very minute spot was seen near the first limb. Not seen afterwards (on Feb. 23^{d} 0^{h}), others seen.

1875, Aug. 30^{d} 1^{h}.—A circular spot of intense blackness was seen near the second limb.

1875, Aug. 30^{d} 23^{h}.—Not seen, perhaps from clouds; other spots seen.

1876, March 7^{d} 0^{h} 30^{m}.—After a careful search only one very small spot was seen. This was without penumbra, but surrounded by bright faculæ (the drawing represents it as circular).

Transits of the Spot and the Limbs of the Sun.

	h.	m.	s.	
☉ 1 ∠	23	29	47·7	
Spot		29	59·0	
☉ 2 ∠		31	57·8	Cloudy afterwards.

Not visible March 9^{d} 0^{h} 30^{m}, though another spot appeared in quite another part of the sun.

Observations of the spots on the disk of the sun are made regularly every day (excepting Sundays) when the sky is clear by Mr. F. Bellamy, and the above are notes which were made by him at the times of observation. ROBERT MAIN

Radcliffe Observatory, Oxford

Erratum in Mr. Wallace's Address

PLEASE allow me to point out an error in my address as given in your issue of September 7 (vol. xiv. p. 407). Instead of "*Pelargonium* of Kerguelen's Land" read "*Pelargonium* of Tristan d'Acunha." This oversight was pointed out to me by Dr. Hooker in time to be corrected in the "Address" as published by the Association. ALFRED R. WALLACE

There is a curious error in Mr. Wallace's address which seems to deserve notice, as otherwise it will be often quoted without suspicion. He remarks (Nature, vol. xiv. p. 407):—

"It must also be remembered, as Mr. Moseley has suggested to me, that a flower which had acquired a brilliant colour to attract insects might, on transference to another country, and becoming so modified as to be capable of self-fertilisation, retain the coloured petals for an indefinite period. Such is probably the explanation of the *Pelargonium* of Kerguelen's Land, which forms masses of bright colour near the shore during the flowering season, while most of the other plants of the island have colourless flowers in accordance with the almost total absence of winged insects."

Now the difficulty is that there is no such *Pelargonium*[1] in Kerguelen's Land, though it is true that the insects are apterous. The flora of Kerguelen's Land is enumerated in the *Journal* of the Linnean Society, xiv. pp. 389, 390. Of such a persistence as that alluded to by Mr. Wallace there is an instance in the case of *Pringlea*, of which Mr. Eaton detected some specimens with petals, though the coloration was, I believe very faint.

W. Thiselton Dyer

Zittel's Palæontology

In the review of Prof. Zittel's "Handbook of Palæontology," which appeared in Nature, vol. xiv. p. 445, it should have been stated, in connection with the occurrence of Radiolaria in pre-Tertiary beds, that Mr. W. J. Sollas, of Cambridge, met with specimens in coprolites from the Upper Greensand, some three or four years ago, *vide Geol. Mag.*, 1873, vol. x. p. 272. Prof. Zittel duly records this fact in his paper on "Radiolaria from the North German Chalk," and mention of it was accidentally omitted in the concluding paragraphs of the review.

Newcastle-on-Tyne, September 25 Henry B. Brady

Visual Phenomena

It is evident A. Mallock (vol. xiv. p. 351) and H. Airy (p. 392) describe two different, though allied, phenomena; the latter describes the appearance of rays of light, which, after entering the eye, meet at a focus, and diverge before reaching the retina; and the former, that of rays which reach the retina before meeting at a focus. For convenience, I shall call these respectively the "over-refracted radiance" and the "under-refracted." They differ in the following particulars in the case of my own eyes:—

The Over-Refracted Radiance	*The Under-Refracted Radiance*
(1) is diminished	is increased
by concave spectacles.	
(2) is increased	is diminished
by convex spectacles.	
(3) any given part may be cut off by advancing an opaque body in front of the pupil from the	
same side as	opposite side to
the given part of the radiance.	
(4) is green outside (or blue, if sunlight is used).	is red outside.
(5) consists chiefly of a more or less perfect ring surrounding indefinite rays. When the radiance is very large the rays disappear in the general brightness.	consists chiefly (when small, entirely) of well-defined rays, mostly forked.
(6) is not materially increased by increasing the size of the pupil; unless the radiance is very large, and even then it is increased much less than in proportion to the pupil.	is increased proportionately, or more than proportionately, to the size of the pupil.

The first four of these must evidently, from the theory of the mode of production of the two kinds of radiance, be constant for all eyes; but not knowing the cause of the last two, I cannot say whether *they* are so, or whether they are peculiar to some eyes. From H. Airy's notes, 4 and 6, it would appear that the latter is the case; for he is evidently short-sighted.

Though contracting my pupil to its smallest size has little effect in reducing the over-refracted radiance, yet by placing still smaller diaphragms in front, I can reduce it almost to a point.

With my naked eye I see both kinds of radiance; No. 3 of the above differences supplying an easy means of separating them, viz., by covering half the pupil. All then that lies on the same side as the exposed part of the pupil, belongs to the over-refracted radiance; and that on the other side to the under-refracted. But as I am rather short-sighted, the over-refracted radiance (which makes a nearly octagonal corona) greatly preponderates; so that I was not previously aware that the other existed with my naked eye. The application of the weakest spectacles (convex or concave) completely abolishes one or the other.

A. Mallock is hardly correct in calling his "phenomenon A" a *limiting* form; he is probably what is often called "long-sighted"—I do not know whether there is any proper name for this peculiarity of vision—for the limiting form of both kinds of radiance is a point. This is what I. W. Ward sees (see p. 423), his eyes being neither too refractive nor too little refractive, but just right (he uses the word "long-sighted" in a different sense from what I have). As most people are either long or short-sighted, they see one or the other kind of radiance with the naked eye; but it also appears from my own case that a person may see both kinds together, and such cannot see a point of light free from radiance, no matter what spectacles he uses, unless he uses a diaphragm. I should be interested in hearing whether, when I. W. Ward looks through spectacles, the rays appear.

The brightness of the point scarcely affects the size of either kind of radiance; but a red glass between the eye and it cuts off the outer edge of the over-refracted radiance.

Unlike H. Airy, I have failed to discern any relation between the positions of the beams of the over-refracted and under-refracted radiances, except that I suspect that the *beams* in the one may in some degree correspond to the opposite *gaps* in the other.

It would appear from the foregoing description of the phenomena in question more probable that the "wedge-shaped" portions of the crystalline lens, alluded to by H. Airy, instead of having the least refractive power, as he suggests, really have the greatest. The question arises, do different eyes differ in this respect? Thos. Wm. Backhouse

Sunderland, September 19

Antedated Books

The writers who have called attention to this point in Nature will have rendered an important service to students if they obtain an amendment in the lax system often followed in this country. But it is to be hoped that the reform may be made complete. It is perfectly easy to have the exact date of issue and the number and letters of the sheets contained in the part stamped on the wrapper or cover, and then by binding these wrappers with the parts, an exact reference to the date is always at hand. This is done with praiseworthy exactness by some of the foreign societies. For instance, I receive this morning a part of the *Annales de la Soc. Entomologique Belgique*, the wrapper of which bears "Tome dixneuvième, fasc. i., signatures 1 à 13 et *a* à *f*. Paru le 16 Septembre, 1876." This it will be seen leaves nothing to be desired. Even in Spain, which we flatter ourselves is so far behind us, they manage this point accurately. The *Annales de la Soc. Esp. de Hist. Nat.* bears on the wrapper of each cuaderno the exact day of publication. Now that attention has been called to this point, let us hope that each society will instruct its secretary or editor, to see that the exact day of publication, and a summary of its contents, be stamped on the wrapper of every part issued.

Thornhill, September 19 D. Sharp

OUR ASTRONOMICAL COLUMN

The Binary Star ξ Bootis.—A satisfactory orbit for this fine star is still wanting. Elements founded upon measures to 1833 were calculated by Sir John Herschel (period 117 years); and an orbit, on an extension of measures to 1854, was given by Hind (period 169 years), but later observation has shown them to be inadmissible. The great difficulty encountered in this case undoubtedly arises from the errors which must exist in one or more of Sir W. Herschel's angles, as was pointed out by his son in the *Memoirs of the Royal Astronomical Society*, vol. vi.,

[1] There is a *Pelargonium* in Tristan d'Acunha (see Moseley, in *Journ. Linn. Soc.* xiv. p. 383.)

and in any further investigation the first step must be to ascertain under what interpretation these can best be reconciled with subsequent measures, it being evident that all cannot be accepted as registered. Sir John Herschel considered the angles of 1792 and 1795, especially the former, must be affected with considerable error. These angles are respectively 355°·74 and 354°·9, or by a mean 355°·3 for 1793·76, but if we suppose that they should have been registered in the north-following quadrant, instead of the north-preceding one, the mean would become 4°·7, an angle in much better accordance with the progression shown by the observations of 1782, 1802, 1804, and those of Struve, Herschel, and South about 1821. It might be worth while to determine how far this alteration would lead to a more admissible orbit. At the same time we have to bear in mind Sir W. Herschel's remarks with respect to his observation, 1792, April 20, in *Phil. Trans.*, 1804, p. 367. And equally are we to take into consideration for our guidance the same observer's estimations of distance in 1782 and 1804.

Diameter of Vesta.—At the opposition of 1855, this brightest of the minor-planet group, which during the last spring, as in previous favourable oppositions, was discernible with the naked eye, was observed by Prof. Secchi to present a diameter but little inferior to that of the first satellite of Jupiter, "ma molto più debole di luce, e di colore ranciato carico," and he estimated it at 0″·8; this we find corresponds to a true diameter of 450 miles. The least distance of the planet from the earth in 1855 was 1·26.

Pigott's Comet of 1783.—On the night of November 19, 1783, a comet was discovered by our countryman, Pigott, at York, well known as having also detected the remarkable variable stars, R Coronæ Borealis, R Scuti, and η Aquilæ. Pigott notified his discovery to Mechain, who observed the comet at Paris on the 26th of the same month, and, in conjunction with Messier, determined its positions until December 21. It was at no time visible without the telescope. Elements were calculated by Mechain and Saron, though without satisfactory results on a parabolic hypothesis. Subsequently Burckhardt investigated the orbit without this assumption, and finally arrived at elliptical elements, with a period of revolution of 5·61 years. But the most precise determination of the orbit from the Paris observations has been made by Prof. Peters, of Clinton, U.S., who reduced the observations anew, and introducing Hansen's Tables for the earth's positions, found elements which "represent the whole series to satisfaction." These elements are published in the "Astronomical Notices" issued by Prof. Brünnow, while in direction of the Observatory at Ann Arbor, Michigan (No. 19), but as this periodical is comparatively little known in this country, having been continued for a short time only, we transcribe the orbit here:—

Perihelion Passage, 1783, Nov. 19·93685 M.T. at Paris.

	°	′	″	
Longitude of perihelion	50	17	25·4	M.Eq. 1783·0
" ascending node ...	55	40	30·5	
Inclination	45	6	53·8	
Angle of eccentricity	33	32	8·4	
Log. semi-axis major	0·5133056			
Period of revolution	5·888 years.			

In this orbit the perihelion distance is 1·4593, and the aphelion distance 5·062.

The comet has not been found since 1783. As remarked by Prof. Peters, a major-axis differing but little from the above would have sufficed to bring the comet into close proximity to the planet Jupiter, at one or other of the subsequent aphelion passages, whence it is possible great perturbations may have resulted, even of magnitude sufficient to effect an entire change of orbit. Indeed with the above elements we find the distance of the comet when in aphelion, from the orbit of Jupiter, is only 0·42. Independently of this, there is another cause which might have long operated to prevent the re-discovery of the comet: in 1783 it appeared under nearly the most favourable circumstances possible for observation, yet as before stated it was at no time visible to the naked eye, and while approaching pretty near the earth, did not exceed 8′ in diameter, presenting throughout the appearance of the great majority of telescopic comets.

The orbit of Pigott's comet passes very near to that of the planet Mars: in heliocentric longitude 55°·2, we find the distance is only 0·032, and it is to be remarked that this close approach takes place in one of the regions where the orbit of the lost comet of De Vico also comes into such near proximity to that of the planet; still after M. Leverrier's statement with reference to past perturbation of De Vico's comet by Mars, we are not to suppose that the bodies can be probably identical.

With respect to the introduction of Pigott's comet into our system, small variation in the major-axis assigned by Prof. Peters would have caused a very close approach of the comet to Jupiter at the aphelion passage immediately preceding the comet's appearance, or early in 1781.

THE SELF-FERTILISATION OF PLANTS

Mr. Thomas Meehan, one of the most acute and thoughtful of American botanists, has several times during the present year brought before the Philadelphia Academy of Natural Sciences the subject of the fertilisation of plants. He has observed that there are plants with conspicuous and attractive flowers, which are as much adapted to secure self-fertilisation as other flowers are for cross-fertilisation. One of his examples is the green-house annual, *Browallia elata*, belonging to the order Scrophulariaceæ, having an attractive blue flower. Not only does it produce abundance of perfect seeds without insect aid, but also the entrance of an insect would ensure self-fertilisation. The style is nearly as long as the corolla-tube, and the slightly longer stamens are arranged closely around it. Two of the anthers are inverted over the stigma, and their connective is densely bearded, appearing like petaloid processes, completely closing the tube of the corolla. No insect can thrust its proboscis into the tube except through this mass; and if it has foreign pollen adherent to it, it will be cleaned off by the beard. Furthermore, the very act of penetration will thrust the anthers forward on to the pistil, and aid in rupturing the pollen sacs, and securing self-fertilisation.

Another phenomenon, the "sleep" of plants, or closing of the flowers at nightfall, has been found by Mr. Meehan to have reference to self-fertilisation in *Claytonia virginica* (order Portulacaceæ) and some buttercups, which seed abundantly, without being visited by insects. In Claytonia, the stamens, on expanding, fall back on the petals expanded during daylight. At night, when the flower closes, the petals carry the anthers into close contact with the stigmas, and actual fertilisation only occurs in this way. In many cases, the stamens recurve so much as to be considerably doubled up by the nocturnal motion of the petals; thus the anthers are not brought into contact with the stigmas, and the flowers are barren.

In *Ranunculus bulbosus*, in the evening following the first day's expansion of the flower, Mr. Meehan has found the *immature* anthers and the young stigmas covered with pollen-grains. This would naturally be supposed to be the consequence of insect visits; but no insect visits had taken place in the cases examined. However, on carefully studying the flower it was found that coincidently with its expansion, a single outer series of stamens shed their pollen into the petals, from which it easily fell to the immature anthers and the stigmas when the flower closed for the night. Another equally remark-

able instance of self-fertilisation occurs in *R. abortivus*, whose petals do not close at night. It seeds profusely, yet is wholly neglected by insects, notwithstanding that it possesses large nectariferous glands. Instead of the flower closing, the slender pedicels droop at night, inverting the flower, and thus allowing the pollen to fall from the petals, on which it is shed, upon the stigmas. Mr. Meehan concludes that some deeper purpose than has yet been conceived governs the fertilisation of plants. In view of these examples, nature cannot "abhor" in-and-in-breeding, and it can hardly be that colour, fragrance, and honeyed secretion in flowers have been developed solely to secure cross-fertilisation. Evolutionists will await with interest further researches by Mr. Meehan, and confirmatory evidences from other inquirers.

THE BRITISH ASSOCIATION

REPORTS

Mr. Chrystal read the following summary of a Report upon a *Comparison of the B.A. Units of Electrical Resistance* that had been performed by himself and Mr. S. A. Saunder.—The experiments, of which I have here an account, were undertaken for the purpose of comparing the British Association Standards of Resistance now deposited in the Cavendish Laboratory at Cambridge. In the account of the work Mr. Saunder and myself have endeavoured as much as possible to enable anyone who consults it to judge by internal evidence of the accuracy of the comparison.

The experiments were so arranged as to give a check on their own accuracy.

In work of this kind the limit of accuracy is much sooner reached in the temperature than in the electrical measurements. It is to them therefore to which the greatest attention has to be given.

We took advantage of an extremely convenient source of nearly constant temperature in the tap-water of our experimenting room, which we found by careful observation to remain constant within the tenth of a degree centigrade for a sufficiently long time. By means of this we could find the differences between the resistances of the several coils at temperatures all near 10° C. The method used for obtaining these differences was a very convenient one, described by Prof. Carey Foster in the October number of the *Journal of the Society of Telegraph Engineers* for 1874.

To obtain the co-efficients of resistance-temperature variations it was necessary to make resistance measurements at a higher temperature. The temperature chosen was 16° C.

The coils were brought to this temperature by careful nursing for an hour or more.

The results of these experiments combined with those at the lower temperature gave the variation co-efficients. The differences at any given temperature could then be calculated.

Lastly, a series of direct comparisons were made, and the result compared with calculation in order to get an idea of the accuracy of our work.

There is a difficulty in giving a comparison between our results and those of the last measurements given in the British Association Report on Electrical Standards. This arises from a want of definite information about these last measurements.

Unfortunately on most of the coils the brass labels have never been completed as was intended, and although we think we managed to identify the coils described in the report with one exception, yet still more definite information is desirable. It is because we have felt this want that we have made our own report more minute than might otherwise have seemed necessary.

We hope that no ambiguity will exist when the coils are compared again either now to check our results or some ten years hereafter to find whether the standards have varied relatively to each other.

With this caution I give a series of temperatures at which the standards are equal to each other according to our measurements side by side with one of the temperatures given in the report.

		Last found.	B.A. Report.
Pt.Ir.	2	16·1	16·0
,,	3	15·8	15·8
Au.Ag.	58	15·3	15·3
Pt.	35	16·0	15·7
,,	36	15·8	15·7
Pt.Ag.	29	18·2	15·2

We have laid these measurements before the British Association in the hope that they will be found useful and be made accessible to those interested in such matters.

Report of the Committee for effecting the Determination of the Mechanical Equivalent of Heat.—Progress has been made with the experiments undertaken by Dr. Joule on behalf of the Committee. Friction of water is the method employed, and the average result of upwards of sixty experiments is 772·2 in British gravitation units at Manchester. The greatest deviation from the above average is $\frac{1}{200}$.

Experiments have yet to be made on the capacity for heat of the brass of which the calorimeter is constructed, which has provisionally been calculated from the results of Regnault for this alloy. The greatest possible error which may have arisen in this way is believed to be $\frac{1}{400}$th. Dr. Joule also proposes to compare his mercurial thermometers with the air thermometer with a view to obtain accurate boiling points, and thus correct values of the thermometric scale. The greatest correction which it may be found needful to apply on this account amounts to about $\frac{1}{500}$th. These maximum corrections, if taken in the same direction, would necessitate the addition or subtraction of 4·5 from the equivalent above named. The experiments made by Hirn on the friction of water have led him to the number 786; but the average of his results, derived from the friction, boring, and crushing of metals, gives 774.

Assuming that the above experiments and those made by Dr. Joule for the Committee on Standards of Electrical Resistance are to be relied on, the unit issued by it would appear to have a resistance one-fortieth too small. Inasmuch as the locality in which the experiments for that unit were conducted was open to objection, it appears desirable that they should be conducted under more favourable circumstances.

Report of the Committee on the Distribution of Erratic Boulders. Read by the Rev. H. W. Crosskey, M.A.—One hundred and sixty-five additional erratics have been catalogued west and south-west of Birmingham, of which 105 have travelled from considerable distances. West and south-west of the midland table-land a large proportion of the blocks are portions of highly indurated ash-beds. To the north and west granite is much more abundant.

Between the 400 and 500 ft. contour lines at Bothel (North Cumberland) is a large block which has been transported from the north-west portion of Dumfriesshire, about forty miles from N.N.W. to S.S.E. Fragments of Shap Fell Granite occur near Dufton (Westmoreland), 800 feet above the sea-level. The east and north-east boundary of the Arenig dispersion may be roughly defined as extending from Chirk by Cefn, Ruabon, Wrexham, Caergwile, Mold, and the east side of Halkin Mountain to Holywell, and thence in a westerly direction to the Vale of Clwyd. This line nearly coincides with the boundary of the great Northern Granite drift. The Welsh and the northern drifts have to a slight extent crossed the average boundary, and a few Arenig boulders have crossed the estuary of the Dee into the peninsula of Wirral, where they become mixed with the very abundant northern drift from the Lake district and the south of Scotland. The felspathic blocks from the Arenig range have radiated to great distances over an area extending from N.N.E. to E., and to short distances from east to south-east; and have found their way across valleys and over watersheds and high mountains. The direction of the glacial striæ on rock surfaces in the eastern part of North Wales as well as in the Arenig mountains, agrees in general with the course taken by the boulders.

The Committee invoke the assistance of geologists in carrying on their investigation. Schedules indicating the particulars required, may be had from the secretary. The rate at which the boulders are disappearing, owing to agricultural and building operations, makes it desirable to register their occcurrence without delay.

The report of the Close Time Committee gave an account of the steps which led to the passing of Mr. Chaplin's Bill for the Preservation of Wild Fowl last Session, and included a circular extensively distributed by the Committee to further that object. Lord Walsingham, Mr. Chaplin, and Mr. Rodwell were warmly thanked for their exertions in the matter. The Committee thought it possible that something further might be done to regulate the proceedings of bird-catchers; but the difficulties in the way appear so serious, that immediate success is not expected. The Sea Birds Preservation Act continues to work satis-

factorily on the whole, though there is reason to fear that its provisions have been disregarded in certain places. A few prosecutions in the coming year may be useful. The East Riding Justices have, with the assent of the Home Secretary extended the close time on the Yorkshire coast from August 1 to August 15.

Dr. M'Kendrick read the report of the committee *On Intestinal Secretion and Movement.* The conclusions to which the Committee had come were—First, that the application of various soda and potash salts to the intestinal mucous membrane produced a more or less profuse secretion, that caused by sulphate of magnesia, acetate of potash, sulphate of soda, and tartrate of potash and soda being most abundant; second, that the presence in the intestines or in the blood of atropia, morphia, chloral, &c., did not prevent the abstraction of sulphate of magnesia; third, that the splanchnic nerves were, as usually admitted, the vaso-motor nerves of the intestines, but either had no centrifugal fibres to their muscular coats or affected them only indirectly by diminishing their supply; fourth, the secretory nerves of the intestines had the small ganglia of the solar and superior mesenteric plexuses for their centres, and this secretion was unaffected by the splanchnics, the vagi, or the dorso-lumbar parts of the cord; fifth, destruction of the lumbar part of the cord after extirpation of the solar plexus produced hæmorrhage, or hyperaemia of the intestinal mucous membrane, which was absent after the division of the splanchnics, destruction of the semilunar ganglia and solar plexus, or division of the mesenteric nerves themselves; and sixth, the splanchnics were the afferent nerves for peristalsis of the intestines, the efferent stimulus probably reaching its intraparietal ganglia through the lumbar cord and the abdominal sympathetic, the effect of the former being inhibitory and the latter stimulating to these ganglia.

Mr. Heywood read the *Report of the Commitee on the Metric System.* It pointed out that while the House of Commons had legalised the metric system for contracts and general purposes, no provision was made for the verification of the standards by the authorities, the consequence of which was that they could not be used in this country as they were liable to be seized. The Committee recommended that steps should be taken to have the weights and measures verified in the same manner as those of the imperial system. They regretted the striking out of the Education Code of the clause introduced by Mr. Forster referring to the metric system, and hoped it would be re-introduced. The report also entered into the question of the decimalisation of coinage.

The Report of the Committee on the Use of Steel for Structural Purposes, stated that after repeated correspondence with the Board of Trade, with the view of getting them to settle the conditions under which steel may be used, Colonel Yolland, R.E., Sir John Hawkshaw, F.R.S., and Mr. W. H. Barlow, F.R.S., had been appointed by the Board of Trade to endeavour to arrange these conditions.

Mr. Symons, secretary of the Rainfall Committee, read their Report to Section G. for the past year, from which it appeared that the rainfall of 1874 was slightly below the average, owing to a rather dry spring and exceedingly dry summer. The most remarkable feature of the year was the heavy fall of rain on October 6, when the average fall over England and Wales was slightly above 1 inch in the 24 hours, and the fall at most stations in North Wales and the Lake District was upwards of 5 inches. So heavy a fall over so large an area was rare. The rainfall of 1875 was greatly above the average in England (especially in the Midland Counties), and irregular in Scotland and Ireland. A very heavy rainfall occurred in Wales and Southern England on July 14, the fall in 24 hours exceeding 1 inch at 252 stations, 2 inches at 109, 3 inches at 39, 4 inches at 7, and 5 inches at 3 stations. The Committee reported last year the success of their efforts to improve the geographical distribution of rainfall stations in Ireland, showed that the gauges started at the cost of the Association had been supplemented by many others established at the cost of private individuals, and gave a map showing the present complete distribution of stations. Almost all the observers have proved good ones, and the returns had been forwarded with regularity. The period was too short to yield precise results, but a good system had been inaugurated and was in full operation. The Committee felt they had done service to rainfall work. When they commenced their labours, the weakest part of rainfall observations was the defective geographical distribution of the stations. This defect had now been materially lessened. By the grants of the Association nearly 250 gauges had been erected in districts hitherto without observations.

Mr. Bramwell asked what the Committee meant to do in the future.

Mr. Symons said he understood the Association wished to discontinue its grant to the Committee, and that the connection between the two should now cease. This he very much regretted, because if anything happened to himself he did not see how the work of the past could be maintained. Mr. Symons added that we had now in this country a system of observations which was the admiration of all countries. America and other countries were copying us. The system now embraced something like 2,000 stations, so scattered that it was scarcely possible to drop a man down in any place where he would be more than four or five miles from a rain-gauge. The consequence was, that when hydraulic and waterworks questions turned up, data were almost always available which did not exist ten years ago for ascertaining the quantity of water which could be collected from any given gathering ground. With reference to the future maintenance of the system it simply rested with himself.

It was ultimately stated by the President that the Sectional Committee considered the time had now arrived when this work should be taken up in a larger public spirit, and consequently that the grant hitherto made should now cease. This recommendation was made in the confident expectation that those who had hitherto so greatly benefited by the laborious and successful work carried on by Mr. J. S. Symons for the Association, would come forward and make the work of the Rainfall Committee their own. The Committee had also to record its most hearty thanks to that gentleman for his valuable services, which had proved so important to many branches of science, and had redounded to the credit of the British Association.

Mr. J. W. L. Glaisher gave the report of the *Committee on Mathematical Tables.* He stated that the whole of the theta function tables 0° to 89° (360 pp.) were now completed, and a copy taken from the stereotype plates was exhibited to the Section. He also gave an interim report of the Committee on mathematical notation and printing. The Committee had met and agreed to several suggestions with regard to notation, but it seemed desirable to postpone the report till next year, when the report on printing would be ready.

Mr. R. B. Hayward read the report of the Committee upon the improvement of geometrical teaching; it stated that the Committee approved generally of the syllabus issued by the Association for the improvement of geometrical teaching, although they criticised some few portions of it.

SECTION A.—Mathematical and Physical.

One of the papers which excited the most attention was by Prof. Osborne Reynolds, *On the Resistance encountered by Vortex Rings, and the Relation between the Vortex Rings and the Stream-lines of a Disc.* It was illustrated by many most interesting experiments relating to the motion of vortex rings in a large trough of water. The following is an abstract of the paper:—

The comparatively small success which has attended nearly all attempts to refer the various movements of fluids to fundamental laws may, I think, be attributed principally to our being in ignorance of many most important circumstances of motion attending the phenomena with which we wish to deal.

We can see the way in which the surface of a fluid moves, but of the internal motions observation affords us no idea, we having no sense by which to perceive them. Accordingly, such steps as have been made towards success for the most part relate to surface phenomena, or to movements which have been rendered apparent by accident. My object, on the present occasion, is to describe certain results which have been obtained by colouring portions of the water within a tank so as to render them visible. These results are somewhat striking, and I venture to think that they are in some respects in advance of what has been hitherto taught; but they are now brought forward rather as illustrations of the importance of the method of study than on account of their own value.

The Cause of the Resistance to the Motion of Solids through Water not known.—The development of the theory of stream lines with which the name of the late Prof. Rankine is so intimately connected, has been a great advance, from the theoretical side, in the study of fluid motion. This theory, however, only applies

strictly to hypothetical fluids without viscosity, and its results as applied to water fall very far short of experimental verification.

Thus, as was so beautifully illustrated before this Section last year by Mr. Froude, a solid should move through a frictionless liquid in a rigid inclosure without resistance; the liquid moving out of its way, from front to rear, in filaments or streams which, closing together behind, cause pressure which exactly balances the pressure in front. In fact, however, water opposes very great resistance to the rapid motion of solids through it. If a ball which will just float be allowed to fall from a great height into water it will only descend a very short distance; and when we come to speeds like the speed of a shot, a foot of water opposes nearly as much resistance as an inch of iron. Opposite as these facts are to what the stream line theory might lead us to expect, they do not disprove the truth of this theory because it does not take into account the viscosity of water. But it is clear that before we can make much practical use of this theory in dealing with the only fluids with which we have to deal, we must ascertain in what way it is that viscosity affects the behaviour of these fluids, so that it may be taken into account in applying the theory. This is a point on which I think some light is thrown by rendering the motion of the water visible.

The Stream Line Theory applies to the Vortex Ring.—The idea of colouring the water to render its motion apparent was doubtless suggested by the effect of smoke and the beautiful phenomena of the smoke-ring. In the smoke-ring we have an instance of a most important form of fluid motion accidentally rendered invisible, of which we should otherwise have most certainly been in ignorance; as it is, however, it has caught the attention of mathematicians, and in the hands of Sir William Thomson, Prof. Tait, Helmholtz, and others, has led to most important researches.

That which is most striking in the smoke-ring is the regularity and extreme beauty of its internal structure. Our familiarity with objects moving rapidly through the air tends to diminish our surprise at the ease with which these rings move. But when we see these rings in water, this rapid motion and the small disturbance which they cause, although only a few inches below the surface, are, I think, the most striking points of the phenomenon.

Vortex rings in water were exhibited at Edinburgh, in 1871, by Mr. H. Deacon, but only on a very small scale, being formed of a single drop. About three years ago I tried a method of forming them, very similar to that used by Prof. Tait for smoke-rings. This method succeeded perfectly. From an orifice $\frac{3}{4}''$ in diameter, I could send rings the full length of my trough (20 feet), and with velocities so great, that during the first part of their course the eye could not follow them. It would appear, from the absence of all disturbance either behind the ring or at the surface, that these rings must move without resistance; and yet this appears at first sight to be inconsistent with the way in which the speed of the rings diminishes as they proceed, either in water or air. There is, however, a cause for this diminution of speed, which cannot properly be called resistance. The rings grow in size as they proceed, and consequently they are continually adding to their bulk water taken up from that which surrounds them, and with which this forward momentum has to be shared. A loss of velocity must result from this growth in size, and the only question with regard to resistance is whether the one of these is sufficient to account for the other, whether, notwithstanding the loss of velocity, the momentum of the moving mass remains constant.

To determine this I measured (by the best means I could devise) the momentum of a series of equal rings at different distances from this origin; the result was that (within the limits of accuracy of the experiments) there was the same momentum in the rings after they had travelled 15 feet, and were not moving more than 3 inches per second, as when at 2 feet from the origin, and moving more than 5 feet per second. I conclude, therefore, that these rings do move without any appreciable resistance.

When this freedom from resistance is considered along with the internal motion of the fluid in and around these rings, it shows that in them we have an instance, and I believe it is the only one, in which the stream line theory applies accurately to motion in a viscous fluid. The form of the mass of fluid moving forward is not nearly that of the ring, but is an oblate spheroid a good deal longer than this ring which it encloses.

This spheroid, like the ring, is continually growing, but at any instant it has a definite shape, and the motion of the water which surrounds it, is at that instant exactly the same as it would be according to the stream line theory if the spheroid were solid and the water were frictionless.

The spheroidal form of the bounding surface, which, of course being fluid, is perfectly flexible, is maintained against the unequally distributed pressure of the surrounding water by the motion of the water within it, the motion being such that at each point in the bounding surface it causes the same pressure as that arising from the motion of the external water.

The Effect of Viscosity on the Motion of the Ring.—The motion of the internal water, besides maintaining the shape of the bounding surface, is such that at each point of this surface the motion of the water in contact with it on the inside is identical with the motion of that in contact with the outside. So that not only is the bounding surface at each instant definite in form, but every point of the surface is in motion in exactly the same manner as the water in contact with it.

The action of the viscosity of the water in causing the gradual growth of the ring and its attendant mass is not confined to the bounding surface, but extends throughout the moving water both internal and external to this surface. There is a gradual diminution in the velocity with which the water moves along the stream lines from the centres outwards in all directions as far as the motion extends into the surrounding water, and, as is well known, when the velocity of a stream varies from point to point in a section across the direction of motion, the effect of viscosity is towards equalising the velocity. Hence, in the case of the vortex ring, the effect of viscosity will be to diffuse the motion outwards, to diminish the whirling velocity at the centre where greatest, and to extend the space through which the water is in motion, that is, to diminish the velocity and extend the size of each element of the ring.

And it appears that this effect to diminish the velocity and extend the size of the ring is the only effect of viscosity. That is to say, if the water at any instant were to lose its viscosity, then the ring would proceed onwards in exactly the same manner as it was proceeding at that instant, for the internal motion would be just as necessary to balance the external pressures and preserve the form of the bounding surface in frictionless fluid, as in water, and hence the same law must hold between the internal and external motions.

The author then supposes that at a certain instant one of the vortex rings is converted into ice, and further, that there is no friction between the surface of the ice and the surrounding water. He proceeds :—

Whatever might be the resistance of the ideal smooth ice, it is clear that its actual resistance must exceed this by what shipbuilders call its skin resistance, the drag of the water moving past the surface. This may be estimated from the resistance of a plane surface of equal extent when moving edgewise through the water, and this is not much.

This, however, is only one of the effects of the surface friction. Whatever drag the friction may cause on the surface, there is an equal drag on the water moving past it, and thus the surface friction aids the diffusion in diminishing the velocity with which the water would otherwise move in the stream lines near the surface, and so tends to increase the disturbance of the stream lines in the rear of the solid.

Actually we find that the resistance resulting from the disturbance of the stream lines is ten times as great as the mere skin resistance, and so far is a solid, of the shape of the bounding surface of the vortex ring, from moving freely, that if it be set in motion, it stops at once and is altogether dead in the water.

That the disturbance of the stream lines as described above really takes place, is shown when we colour the water. When we first start the solid we see a somewhat irregular vortex ring behind it, which grows rapidly and then breaks up; after this the water behind is all confused, and follows the solid. Whereas with the vortex ring, if there are streaks of colour in the water through which the ring passes, it leaves them so nearly as they were before, that there is scarcely a trace of its path. Thus this disturbance of the stream line appears to be the cause of the resistance encountered by a solid over and above the skin-resistance.

The magnitude of the effect depends on the curvature of the streams, and hence we see why a body having a fine afterpart like a fish encounters so much less resistance than a full body like a spheroid. Whereas if the stream lines were complete according to the theory, the extra surface of the fish should cause it much greater resistance.

Relation between the Vortex Ring and the Stream Lines of a Disc.—Another matter on which I have been able to throw some light by colouring the water, relates to the form of the stream lines of a thin surface, such as a disc. It is, I believe, generally assumed that the theory of stream lines shows all bodies would

move without resistance in a perfect fluid; and that thin surfaces are no exception to the general rule, but I am not aware that any satisfactory figure for the stream line of such bodies has as yet been given.

Now what I have to show raises two very important points in connection with the stream-line theory, even as applied to a perfect fluid. In the first place it will appear that a thin open surface has no stream lines of its own (so to speak) except such as it can claim as forming part of a closed surface. And in the second place it will appear that the closed surface may assume the form of a cylinder of indefinite length continually passing away from the thin surface, in which case the surface or vane does not move freely even through a frictionless fluid. If we place a disc in front of one of these rings, the ring comes on until the disc is against the bounding surface, and then carries the disc on with it. It is certainly surprising to see a flat disc moving freely through the water. I doubt not that the general impression is that a thin flat disc is about the worst form of body to move through water. And so it is, except when it has a vortex ring behind it.

Owing to the growth of the ring, if the speed of the disc be maintained, the ring will gradually fall behind the disc, and the disturbance caused in front will break it up. But if the disc be allowed to move with the ring it will move freely as far as the ring goes. A disc when first started forms its own ring. Thus if a disc be floated on a light bar of wood, when the wood is drawn forward at first, the disc offers considerable resistance to its motion, but this resistance soon dies away, and if then the bar be released, the disc will proceed steadily onward with a gradually diminishing velocity.

A little colour in the water shows how the ring is formed and how it moves onward behind the disc.

The Resistance of an Inclined Vane.—The fact that the disc will start its own ring, will close its own surface, is due to its being symmetrical with respect to this surface. Half a disc will not do it, much less any portion of the spheroid which was inclined to the front.

When we draw a disc or flat surface edgewise through the water it causes a continuous vortex cylinder which, forming at the forward point of the vane passes away behind. The gyratory motion of the water is somewhat disturbed by the friction of the vane sliding past it, but by letting a little air down with the vane the central lines of the vortices may be shown for several feet in length.

Having to form the vortices the forward edge encounters the greatest resistance, and the whole resistance is steady and continuous.

If my reasoning is right these facts are somewhat at variance with the general notion as regards the results of the stream-line theory, and at all events they furnish definite ideas of the results we have to explain. It is, however, with the utmost diffidence that I venture to bring forward my own explanation before such an authoritative body as Section A. in the University of Glasgow, and my chief object has been to illustrate the method of studying fluid motion by observations on the motion of partly coloured water.

On the Protection of Buildings from Lightning, by Prof. J. Clerk Maxwell.—Most of those who have given directions for the construction of lightning-conductors have paid great attention to the upper and lower extremities of the conductor. They recommend that the upper extremity of the conductor should extend somewhat above the highest part of the building to be protected, and that it should terminate in a sharp point, and that the lower extremity should be carried as far as possible into the conducting strata of the ground so as to "make" what telegraph engineers call "a good earth."

The electrical effect of such an arrangement is to *tap*, as it were, the gathering charge by facilitating a quiet discharge between the atmospheric accumulation and the earth. The erection of the conductor will cause a somewhat greater number of discharges to occur at the place than would have occurred if it had not been erected; but each of these discharges will be smaller than those which would have occurred without the conductor. It is probable, also, that fewer discharges will occur in the region surrounding the conductor.

It appears to me that these arrangements are calculated rather for the benefit of the surrounding country and for the relief of ... ouring under an accumulation of electricity, than for ... ion of the building on which the conductor is erected.

What we really wish is to prevent the possibility of an electric discharge taking place within a certain region, say in the inside of a gunpowder manufactory. If this is clearly laid down as our object, the method of securing it is equally clear.

An electric discharge cannot occur between two bodies, unless the difference of their potentials is sufficiently great, compared with the distance between them. If, therefore, we can keep the potentials of all bodies within a certain region equal, or nearly equal, no discharge will take place between them. We may secure this by connecting all these bodies by means of good conductors, such as copper wire ropes, but it is not necessary to do so, for it may be shown by experiment that if every part of the surface surrounding a certain region is at the same potential, every point within that region must be at the same potential, provided no charged body is placed within the region.

It would, therefore, be sufficient to surround our powder-mill with a conducting material, to sheathe its roof, walls, and ground-floor with thick sheet copper, and then no electrical effect could occur within it on account of any thunderstorm outside. There would be no need of any earth connection. We might even place a layer of asphalte between the copper floor and the ground, so as to insulate the building. If the mill were then struck with lightning, it would remain charged for some time, and a person standing on the ground outside and touching the wall might receive a shock, but no electrical effect would be perceived inside, even on the most delicate electrometer. The potential of everything inside with respect to the earth would be suddenly raised or lowered as the case might be, but electric potential is not a physical condition, but only a mathematical conception, so that no physical effect would be perceived.

It is therefore not necessary to connect large masses of metal such as engines, tanks, &c., to the walls, if they are entirely within the building. If, however, any conductor, such as a telegraph wire or a metallic supply-pipe for water or gas comes into the building from without, the potential of this conductor may be different from that of the building, unless it is connected with the conducting-shell of the building. Hence the water or gas supply pipes, if any enter the building, must be connected to the system of lightning conductors, and since to connect a telegraph wire with the conductor would render the telegraph useless, no telegraph from without should be allowed to enter a powder-mill, though there may be electric bells and other telegraphic apparatus entirely within the building.

I have supposed the powder-mill to be entirely sheathed in thick sheet copper. This, however, is by no means necessary in order to prevent any sensible electrical effect taking place within it, supposing it struck by lightning. It is quite sufficient to inclose the building with a network of a good conducting substance. For instance, if a copper wire, say No. 4, B.W.G. (0·238 inches diameter), were carried round the foundation of the house, up each of the corners and gables and along the ridges, this would probably be a sufficient protection for an ordinary building against any thunderstorm in this climate. The copper wire may be built into the wall to prevent theft, but should be connected to any outside metal such as lead or zinc on the roof, and to metal rain-water pipes. In the case of a powder-mill it might be advisable to make the network closer by carrying one or two additional wires over the roof and down the walls to the wire at the foundation. If there are water or gas-pipes which enter the building from without, these must be connected with the system of conducting-wires, but if there are no such metallic connections with distant points, it is not necessary to take any pains to facilitate the escape of the electricity into the earth.

Still less is it advisable to erect a tall conductor with a sharp point in order to relieve the thunder-clouds of their charge.

It is hardly necessary to add, that it is not advisable, during a thunderstorm, to stand on the roof of a house so protected, or to stand on the ground outside and lean against the wall.

On a Cyclone Periodicity, in connection with Sun-spot Periodicity, by C. Meldrum.—This paper is a continuation of the one published in the report for 1874; it contains a discussion of the cyclones that occurred in the Indian Ocean, from the equator to 32° S. and 0° to 120° E., in the years 1868-75. From 1868 to 1872 the cyclonic area increased, and since 1872 it has been decreasing. In 1868 it was two millions of square miles, in 1872 between four and five millions, and in 1875 nearly two millions. The rainfall over the globe generally seems to have had a similar march, the rainiest year being 1872.

Mr. O. J. Lodge exhibited diagrams of a model to illustrate mechanically the passage of electricity through metals, electrolytes, and dielectrics, according to Maxwell's theory. The model consisted of an endless cord passing with friction through buttons supported on elastic strings, and by altering the relation

between the friction and the elasticity of different parts it could be made to exhibit very completely the phenomena observed when an electromotive force is made to act (1) between the ends of a metal wire; (2) through an electrolytic liquid; (3) in an accumulator with perfectly insulating dielectric; (4) across a dielectric which is homogeneous, but has a slight conducting power; (5) across a non-homogeneous or stratified dielectric, in which a "residual charge" is possible. To illustrate in a simple manner the phenomena observed in a submarine cable, the cord might be made elastic.

Capt. A. W. Baird, R.E., contributed a paper *On Tidal Operations in the Gulf of Cutch.*—The primary object of the operations was to determine whether secular changes in the level of the land at the head of the gulf, *i.e.*, the "Runn of Cutch," are taking place. Col. Walker at first intended to restrict the observations to a few weeks' duration, but he found that by extending them to a period of a little over a year, scientific results of the highest value would be obtained, and also that this course would be necessary in order to obtain data sufficient to detect minute changes in the relative level of land and sea. The author described the difficulties that had been experienced; but stated that the whole of the tidal and meteorological observations were in progress of reduction, and when completed were likely to afford results of importance. It was hoped that the effect of the wind and barometer upon the tide might be determined more accurately than had yet been done. Tracings of the actual diagrams were exhibited, and the tidal curves were seen to be very regular and continuous.

The number of important experiments shown before Section A at this meeting was very remarkable. Besides the experiments of Prof. Osborne Reynolds already referred to, there were several others relating to liquids. Prof. James Thomson illustrated experimentally the origin of the windings of rivers in alluvial plains, as explained in a recent paper in the Royal Society's *Proceedings*, and Sir William Thomson showed many experiments upon the precessional motion of a spheroidal top filled with liquid. Sir William Thomson also exhibited a new form of astronomical clock with a free pendulum actuated by an independent governor to give approximately correct uniform motion to the escapement-wheel. Mr. H. W. Bosanquet illustrated experimentally his paper on the conditions of the transformation of pendulum vibrations, and Mr. Colin Brown exhibited his voice harmonium in connection with his paper on just intonation. Sir William Thomson explained a method of taking deep-sea soundings in a ship moving at high speed by means of pianoforte-wire and an apparatus which was exhibited and explained. The Rev. J. Kerr described an experiment proving rotation of the plane of polarisation of light reflected from a magnetic pole. The attendance throughout was excellent, and the room was generally crowded; in fact in recent times there has been no meeting at which so much interest has been taken in the proceedings of this Section. Owing to the number of papers the Section was divided into two on the Monday and Tuesday, and the Section met to finish the work on Wednesday. Saturday was, as usual, devoted to mathematics. There were altogether twenty-three mathematical papers, among which may be mentioned those by Prof. Cremona on systems of spheres and systems of lines, by Prof. Tait on two general theorems relating to closed curves, by Mr. J. W. L. Glaisher, giving determinants expressing the number of partitions of a number, and the sum of the divisors of a number; by Prof. Jung, of Milan, on the inverse problems of the moments of inertia and the moments of resistance of a plane figure, and on a construction for the central nucleus (*Centralkern*, of Culmann) of a body, and by Mr. G. H. Darwin on graphical interpolation and integration. Two new committees were appointed at the recommendation of Section A, one for commencing experiments upon the elasticity of wires, and the other upon the lunar disturbance of gravity.

SECTION C.—GEOLOGY.

On the Upper Limit of the essentially Marine Beds of the Carboniferous System in the British Isles, and the necessity for the establishment of a Middle Carboniferous Group, by Prof. E. Hull, M.A., F.R.A.S.—Prof. Hull distinguished seven stages in the Carboniferous Rocks, each stage being capable of identification by its fossils over large areas in Great Britain and Ireland. These stages are:—

(1) Upper Coal Measures.
(2) Middle Coal Measures.
(3) Lower Coal Measures or Gannister Beds.
(4) Millstone Grit.
(5) Yoredale Rocks.
(6) Carboniferous Limestone.
(7) Lower Limestone Shale.

He argued that as thirty-three out of fifty-three species of marine shells pass from the Carboniferous Limestone upwards into the Gannister Beds, while only five passed up into the Middle Coal Measures, a palæontological break was indicated of such magnitude as to warrant a more distinct separation of the Gannister Beds from the Middle Coal Measures; especially as the shells of the former are marine, while many palæontologists regard those of the latter as of fresh-water origin. He therefore proposed to include all from the Gannister Beds to the Yoredale Rocks as Middle Carboniferous; the term Lower Carboniferous to include as at present the Carboniferous Limestone and Lower Limestone Shale.

Note on Sections exhibiting Variation of thickness in the Middle Coal Measures of West Lancashire, by C.E. de Rance, F.G.S.—The sections described by the author lie between Prescot and Barnsley, where the Middle Coal Measures, containing several thick coal-seams, and the Gannister Beds, containing few important seams, are represented. Having made many sections of the Middle Coal Measures of the district, Mr. de Rance was satisfied that the amount of the subsidence from south to north for a distance of ten miles, increased at the rate of about 60 feet per mile, and that the deposition of the Coal Measure strata kept pace with the subsidence.

On the Changes affecting the Southern Extension of the Lowest Carboniferous Rocks, by G. A. Lebour, F.G.S.—The author contended for the division of the Carboniferous Rocks into Upper and Lower, drawing the line between the Millstone Grit and Yoredale Series. Dealing with the lower division, it was pointed out that the Upper Old Red Sandstone was in part identical with, or passed upward into Macharen's "Calciferous Sandstone," known in the North of England as "Tuedian," and in Ireland as "Valentian." In England the upper limit of the "Tuedian" is equally indefinite, as the series dovetails into the lower members of the "Bernician" Group, in which term the author includes the "Yoredale Series and Calcareous Group in part, Scar Limestone Series and Calcareous Group in part, *plus* Carbonaceous Group in part."

On the Mountain Limestone on the West Coast of Sumatra, by Prof. Ferdinand Roemer, of Breslau.—Dr. Verbeck, Director of the Dutch Geological Survey of Sumatra, sent to the author a large collection of fossils from the west coast, for determination and description. The result of this investigation is that the Mountain Limestone is developed on the western coast of Sumatra, with mineralogical and palæontological characters, very similar to those of the same formation in Europe. The same genera of shells, and partly the same species occur in these widely remote localities. Hitherto the Mountain Limestone has only been known to occur in the Malay Archipelago in Timor, a small but characteristic Mountain Limestone fauna from that island having been described by Prof. Beyrich. It may be expected that by-and-by the Mountain Limestone may be ascertained to have a wider range in the Malay Archipelago than is at present known. From the geographical position of Java, between Sumatra and Timor, it is probable that a zone of Mountain Limestone, and perhaps of other palæozoic rocks, may be found to exist there, although partly hidden by volcanic and tertiary deposits.

On some New Minerals and on Doubly-refracting Garnets, by Prof. A. von Lasaulx, of Breslau.—Prof. von Lasaulx exhibited specimens of a new mineral from Girgenti, Sicily, where it occurs in small cubes on crystals of sulphur and celestine. Its chemical composition is,—silica 86 per cent., water 3 per cent., iron and strontium small quantities, and sulphuric acid, or some acid of the thionic series not yet determined, 7 per cent. From the behaviour of the mineral before the blowpipe, the author named it melanophlogite. The author also described a series of garnets exhibiting the phenomena of double refraction.

On the Raised Beaches of the Cumberland Coast between Whitehaven and Boness, by A. Russell, C.E., F.G.S., and T. V. Holmes, F.G.S.—The authors exhibited a map showing several fragments traced by themselves, of raised beaches sloping inland from 25 ft. above the present sea-level to an upper limit of 40 ft. The terraces are covered by low gravel ridges parallel to the old

cliff line, similar to the little mounds left by the sea at the present day half-way between the mark of the highest spring tides and that of the lowest neap tides. With regard to the date of the elevation of the beaches, the authors observed that all the evidence available tended to place it before the time of the Roman occupation.

Tidal Retardation—Argument for the Age of the Earth.—The Secretary read a paper by James Croll, LL.D., F.R.S., of the Geological Survey of Scotland, *On the Tidal Retardation Argument for the Age of the Earth.* Many years ago Sir William Thomson demonstrated from physical considerations that the views which then prevailed in regard to geological time and the age of our globe were perfectly erroneous. His two main arguments were—first, that based on the sun's possible age; and secondly, that based on the secular cooling of the earth. More recently he has advanced a third argument (*Trans.* Geol. Soc. of Glasgow, vol. iii., p. 1), based on tidal retardation. It is well known that owing to tidal retardation the rate of the earth's rotation is slowly diminishing, and it is therefore evident that if we go back for many millions of years we reach a period when the earth must have been rotating much faster than now. Sir William's argument is, that had the earth solidified several hundred millions of years ago the flattening at the poles and the bulging at the equator would have been much greater than we find them to be. Therefore, because the earth is so little flattened it must have been rotating, when it became solid, at very nearly the same rate as at present. And as the rate of rotation is becoming slower and slower, it cannot be so many millions of years back since solidification took place. A few years ago I ventured to point out (NATURE, August 21, 1871; "Climate and Time," p. 335) what appeared to be a very obvious objection to the argument, and as the validity of the objection, as far as I am aware, has never been questioned, I have been induced to believe that the argument referred to had been abandoned. But I find that Prof. Tait in his work on "Recent Advances in Physical Science," restates the argument as perfectly conclusive, and makes no reference whatever to my objection. As the subject is one of very considerable importance, I may be permitted to direct attention to the objection in question, which briefly is as follows:—

It has been proved by a method pointed out a few years ago (*Philosophical Magazine*, May, 1868, pp. 378–384, February, 1867, p. 130, "Climate and Time," Chap. xx. *Transactions* of Geological Society of Glasgow, vol. iii., p, 153), and which is now generally admitted to be reliable, that the rocky surface of our globe is being lowered, on an average, by subærial denudation at the rate of about 1 foot in 6,000 years. It follows as a consequence from the loss of centrifugal force resulting from the retardation of the earth's rotation, occasioned by the friction of the tidal wave, that the sea-level must be slowly sinking at the equator and rising at the poles. This, of course, tends to protect the polar regions, and expose equatorial regions to subærial denudation. Now it is perfectly obvious that unless the sea-level at the equator has, in consequence of tidal retardation, been sinking during past ages at a greater rate than 1 foot in 6,000 years, it is physically impossible the form of our globe could have been very much different from what it is at present, whatever may have been its form when it consolidated, because subærial denudation would have lowered the equator as rapidly as the sea sank. But in equatorial regions the rate of denudation is, no doubt, much greater than in the temperate regions. It has been shown in the papers above referred to, that the rate at which a country is being lowered by subærial denudation is mainly determined not so much by the character of its rocks as by the sedimentary carrying power of its river systems. Consequently, other things being equal, the greater the rain-fall the greater will be the rate of denudation. We know that the basin of the Ganges, for example, is being lowered by denudation at the rate of about 1 foot in 2,300 years, and this is probably not very far from the average rate at which the equatorial regions are being denuded. It is therefore evident that sub-ærial denudation is lowering the equator as rapidly as the sea-level is sinking from loss of rotation, and that consequently we cannot infer from the present form of our globe what was its form when it solidified. In as far as tidal retardation can show to the contrary, its form may have been as oblate as that of the plant Jupiter when solidification took place.

There is another circumstance which must be taken into account. The lowering of the equator by the transference of materials from the equator to the higher latitudes must tend to increase the rate of rotation, or, more properly, it must tend to lessen the rate of tidal retardation.

On Siliceous Sponges from Carboniferous Limestone near Glasgow, by John Young, F.G.S.—Mr. Young observed that siliceous sponges had not hitherto been obtained from deposits of Carboniferous Limestone age in Britain. Recently, however, Mr. John Smith had discovered large numbers of them in fissures in a limestone at Cunningham Baidland, near Dalry, Ayrshire. The limestone bed in which they occur is 40 feet thick, and belongs to the upper division of the Carboniferous Limestone series. It contains, at different horizons, producti and spirifers, corals, crinoids, and polyzoa. Prof. Young and the author proposed to name them *Acanthaspongia Smithii*.

On the Granite of Strath-Errick, Loch Ness, by James Bryce, LL.D.—Having ascertained that the gold of Sutherland occurred not in quartz veins, but in the granite itself, Dr. Bryce tested the granite of Strath-Errick, and was rewarded by finding gold there also, although in small quantities. Proceeding to examine more carefully than had previously been done the relations of this granitic mass to the surrounding rocks, he found that, although at one locality it clearly overlaid the Lower Old Red Sandstone, in another place it alternated with slate, as if the slate had been brought up by the granite. It was remarkable that, although the slates are cut up by veins of the granite, none pass into the Old Red strata. The author considered that the evidence in favour of the intrusive character of the granite was incontrovertible.

On the Upper Silurian Rocks of Lesmahagow, by Dr. Robert Slimon.—Dr. Slimon gave an interesting historical account of the mapping of the Upper Silurian rocks of Lesmahagow, and of the discovery and determination of their remarkable crustacean fauna.

On the Age, Fauna, and Mode of Occurrence of the Phosphorite Deposits of the South of France, by J. E. Taylor, F.G.S.—The author visited the phosphorite caverns within the last two months, and gave an account of what he saw.

On a Deep Boring for Coal at Scarle, Lincolnshire, by Prof. E. Hull, M.A., F.R.S.—The boring, after penetrating the Lower Lias, New Red, and Permian, entered the Carboniferous formation at the depth of 1,900 feet. The Carboniferous Rocks bored through were grey sandstones, with plants and shales with anthracosia, &c., 55 feet; calcareous shales and earthy limestone, 65 feet; fine breccia, 4 feet; chocolate-coloured clay, 6 feet. This succession was very puzzling. The beds above the breccia were pronounced by Prof. Ramsay and the author, without any consultation, to be Yoredale Rocks, but since the breccia has been reached, Prof. Hull inclines to regard it as belonging to the uppermost beds of the Coal Measures. As the boring is still going on, it is hoped that something more definite may be discovered.

A feeder of water was tapped in the Keuper Sandstone at the depth of 917 feet, and a still more powerful one in the Bunter Sandstone, at 1,250 feet, sent a jet of clear water 4 feet above the ground. The water must percolate from the outcrop of these beds ten or twelve miles to the west, being prevented from rising by the presence of the overlying impervious Lias Clay.

On Tertiary Basaltic Dykes in Scotland, by R. L. Jack, F.G.S., of the Geological Survey of Scotland.—Mr. Jack exhibited a map showing the courses of all the dykes of this age traceable for any distance which have hitherto been mapped by the Geological Survey, and described their peculiarities, referring specially to their avoidance of faults and other obvious lines of weakness. One dyke crosses Scotland from Helensburgh to Grangemouth, while two others maintain a parallel course from the heads of the River Irvine to the head of the Tweed, a distance of nearly forty miles. It was pointed out that a number of the larger dykes tend to converge towards the peninsula between Lochs Riddun and Striven, where, however, no evidence of volcanic activity, either in the shape of lava-flows or plugged-up vents, is known to exist.

On certain Pre-Carboniferous and Metamorphosed Trap-Dykes and Associated Rocks in North Mayo, by W. A. Traill, M.R.I.A., of the Geological Survey of Ireland.—In the district between Ballycastle and Belmullet the rocks belong either to the Carboniferous age or are older and metamorphosed. The author distinguishes at least two sets of dykes, both being basaltic. Those of the newer set run in straight lines, traverse both metamorphic and Carboniferous strata, and appear to fill vertical fissures or to come up along lines of fault. The older dykes

disturb only the metamorphic rocks, occur chiefly in sheets, and are often crumpled and contorted, while fragments of them occur in a conglomerate at the base of the Lower Carboniferous. This set must therefore be pre-Carboniferous, while the upper set is post-Carboniferous, and possibly Miocene.

SECTION D.—BIOLOGY.

Department of Anatomy and Physiology.

ADDRESS BY JOHN G. MCKENDRICK, M.D., F.R.S.E., VICE-PRESIDENT.

The Future of Physiological Research.

BEARING in mind the fact that one of the objects of the British Association is to interest the public in the advancement of scientific truth, it has been the practice of the presidents of the various sections to make some remarks of a general character, or to give a *résumé* of the recent progress of science in their particular department. I shall follow so far the examples of my predecessors. I shall not attempt to enumerate, far less to describe, the contributions made to anatomical and physiological science during the past year, because that would entail a long and wearisome report regarding investigations with which most of us are already acquainted by the perusal of those excellent summaries that appear from time to time in our scientific and medical periodicals. With the view of limiting the scope of this address, I propose to offer a few observations bearing generally upon some of the scientific and social relations of anatomy and physiology, with the view of interesting the public in what we have been doing, and what we hope yet to do.

These sciences present different views of the same great system of truth. Each can be conceived as existing independently, while at the same time the one science is the complement of the other. Anatomy is the science of organic form, while physiology is that of organic function. The anatomist investigates structure, its form, general arrangements, and laws, and he may include in his survey the purposes or functions which the structure fulfils. Recently an opinion has been prevalent, and has cropped up in various quarters, that anatomy is but a preparatory science for physiology. This opinion has probably arisen in consequence of the rapid growth of physiological science during the last twenty or thirty years. But there can be no doubt that anatomy has a *rôle* of her own by no means inferior to that of physiology. She has to educe the formal laws which determine the structure of organised bodies and their parts, and thus she establishes the basis for scientific classification and arrangement. Anatomy is the beginning, of course, of all medical education, and the ground work on which the practical arts of medicine and surgery are reared; but in a broader sense, the science has to do with the structure of every animal, from the simplest to the most complex, and from the facts obtained in the investigation of the structure of any animal, we are able to recognise the relationships it has with other animals, or, in other words, its position in the zoological scale.

Dr. McKendrick then proceeded to speak of the methods of anatomy, histology, the methods of physiology, the vivisection question, the importance of teaching biology, the practical aspects of anatomy and physiology, the importance of investigations on the physiological action of active substances, the relation of physiology to medicine; after which, with reference to the relation of physiology to psychology, he remarked that as physiology is intimately connected with psychology, or the science of mind, and as this department of physiological work has lately been his chief study, he may be allowed to refer to it a little more in detail.

Psychology may be divided into two parts: first, all those phenomena which we may include under the term mind properly so-called, such as feeling, volition, and intellectual processes; and second, the phenomena which are associated with, and which indicate the alliance between, mind and matter. Every mental act may be regarded in the present state of knowledge as having a double aspect—on the one side it is known to our consciousness, and on the other side it is the result of a number of physical processes occurring in the brain.

The Methods of Psychology.

In the investigation of mental phenomenon, two modes of inquiry have been followed: first, that of introspection and reflection, in which the investigator looks within himself for the facts of his experience; and second, that of the examination of physiological processes which coincide with sensorial or mental changes. It is evident that the first of these methods, usually called the subjective, is open to the objection that by it a mind attempts to observe its own operations, and that the proceeding is somewhat analogous to asking a machine to investigate its own-mechanism. This objection urged in other words by Comte, Maudsley, and others, may be answered by replying that the subjective method does not attempt to explain the physiological phenomena concomitant with mental states, but the laws which regulate these mental states themselves. Suppose a complicated machine possessed consciousness, I can readily understand that by the exercise of this consciousness it might be unable to discover the relation and mechanism of its own parts, because in attempting to do so the machinery would be so interfered with as to prevent normal action; but it might still be able to study the products of its operations. I do not, therefore, decry this old method of psychological research as it is so much the fashion to do in these days. Apart altogether from the philosophical speculations and systems of philosophy founded upon them, I think many data accumulated by such men as Locke, Berkeley, David Hume, Thomas Reid, Dugald Stewart, Thomas Brown, Sir William Hamilton, and James Mill, have as good a right to be considered correct as many of the quasi-metaphysical conceptions of physical science. Subjective inquiry carried on by such men cannot be given up as a mode of psychological research. It may not carry us much further than it has done, but it has rendered good service already, and may possibly do more.

But, on the other hand, the objective method appears to me to be the one which, in future, will be principally cultivated, and it is for this reason that, as a physiologist, I wish especially to refer to it.

It is the business of physiology to supply psychology with information regarding physical processes occurring in the nervous system; and it is one of the special features of the physiology of the present day to direct attention to the physical side of mental phenomena. No doubt Aristotle, Hobbes, and Hartley incorporated into their psychological theories much that was purely physiological; but in their days the physiology of the nervous system was in a crude state, and, consequently, did not lead to great results. In comparatively recent times, a new inductive and experimental department of science has arisen, the nature of which is indicated by the term physiological psychology, and which is being diligently cultivated by numerous workers, both at home and abroad. In our own country the writings and researches of Herbert Spencer, Alexander Bain, Dr Laycock, George Henry Lewes, Dr. Maudsley, Dr. Carpenter, Alfred Barratt, and James Sully, and on the continent those of Fechner, Helmholtz, Wundt, Hermann Lotze, Taine, Donders, Plateau, and Dalboef, have excited much interest, and have led to the formation of a new school of thought.

I think it right to mention here specially the name of Prof. Laycock, who has done more, in my opinion, in this field of inquiry than any other member of the medical profession of this country in our time. His teaching has largely contributed to our present humane methods of treating the insane; he has attracted year by year some of the best students of the University of Edinburgh to this important department of medical practice; and his earlier writings incontestably show that, many years ago, and prior to most of the writings of those great men whose names I have just enumerated, he not only recognised the value of physiological research with regard to mental phenomena, but made important contributions himself.

Physiology has thus encroached on psychology, and is attempting to supply from the objective side an explanation of at least the simpler mental phenomena. As a proof of awakened interest in this department, one of the features of the past year has been the appearance of *Mind*, a quarterly journal of psychology, edited by my able friend Prof. Croom Robertson of University College. In the prospectus of this journal, it is stated that "psychology, while drawing its fundamental data from subjective consciousness, will be understood in the widest sense, as covering all related lines of objective inquiry. Due prominence will be given to the physiological investigation of nerve-structure." This quotation indicates the view which the editor takes of the relation of the two sciences, and already valuable papers have appeared on subjects connected with physiological psychology, from the pens of Sully, Lewes, Wundt, and others.

Now a certain class of thinkers are alarmed by work of this kind. They are afraid of the tendency "to represent the mental fact as a physical fact," and they are inclined to shut their eyes to the physical facts connected, undoubtedly, with psychological processes, and to be contented with the study of subjective

phenomena. But as most admit that there are two aspects in which mental phenomena may be viewed, why should not both be looked at carefully? If it be also admitted, that it is impossible to connect any physical process (supposing we knew it) occurring in brain cells with an act of consciousness, what is the use of taking a one-sided view of the phenomena in question? Why not study both sides of the problem, and give up the attempt at reconciliation, which is entirely beyond the pale of our faculties? This mystery of mind and matter has puzzled thoughtful men from the earliest times. Some have attempted a reconciliation. They have reasoned in a circle, so that most people, after perusing their works, are no nearer an ultimate solution than they were at the beginning. We always come back to this view of the case, namely, that every fact of mind has two aspects, a physiological and a psychological. That is one way of looking at the problem, and it is the one which, in the present state of knowledge, personally I prefer. But there is another. Thus, as has been well argued by Mr. George Henry Lewis in his recent work, "Problems of Life and Mind," two very different descriptions may be given of one and the same mental activity. The one may be expressed in the language of psychology, which is the language we commonly use to describe our feelings; the other may be stated in the language of physiology, a language intelligible only to those acquainted with the present state of physiological research. He says: "All that we have to guard against, is the tendency to mistake difference of aspect for difference of process, and to suppose that changes in feeling can exist independently of changes in the organism, or that any change in the organism can be effected otherwise than by some previous change." This way of stating the question may be more satisfactory to some minds. At all events, it is a fair attempt to solve the puzzle of our present state of existence, in which we are constantly brought face to face with the antithesis of object and subject.

Abandoning these speculations which are fruitless in practical effects, let me now endeavour very briefly to indicate the lines of inquiry in the domain of physiology, along which progress has been and may be made in the attempt to solve psychological phenomena; and I wish it to be understood that I do not take these in any logical order, but merely adduce them by way of illustration. It will also be my aim not so much to describe what has been done in the past, as to indicate what remains to be done in the future.

Research in Physiological Psychology.

First of all, then, it is quite evident that all researches on the general physiology of the great nerve centres are of paramount importance. Such researches as those of Hitzig, Fritsch, and Ferrier on the excitability of the cerebral hemispheres, supplying new ideas regarding the mechanism of the brain as a compound organ; of Wundt on central innervation and consciousness, in which he discusses in a manner never before attempted, the phenomena of reflex excitation; of William Stirling on the summation of excitations in reflex mechanisms; of various French physiologists on the mode of action of ganglia in insectæ; and of many others, are all recent important contributions to this department of science. Here, however, we have to confess that we have little accurate information regarding the minute structure of the parts involved, and consequently no anatomical basis on which to found our views. We have a general idea of strands of nerve-fibres and groups of nerve-cells of various forms, but we have no precise knowledge of the relative quantity of these, or of the relations of one group of nerve-cells to another group. We are unacquainted with any peculiarity in structure, for example, by which even an accomplished histologist could identify three microscopical sections as respectively portions of the brain of a man, of a monkey, and of a sheep. All this has still to be worked out. Every little area of brain-matter has to be surveyed and carefully described. Supposing this were done in the case of the human brain, and of the brains of the higher animals, the same must be attempted with the brains of animals lower in the scale. I can then conceive a grand collection of facts which may throw light on the intricate working of different kinds of brains, and, perhaps, afford a rational explanation of certain psychological characters.

Suggested Investigation.

What I mean may perhaps be better understood by a research, which I would suggest by way of experiment. No one who has kept an aviary of small birds—say a collection of our native and foreign finches—can have failed to observe marked differences of character and habits among different members of the same genus, and even among different members of the same species. One manifests cunning, another combativeness, a third kindness to smaller brethren, a fourth bullies all about him, a fifth may usually be quiet and peaceable, but occasionally gives way to uncontrollable rage, and so on. The question arises, then, Have these psychological peculiarities any organic basis, any explanation in the structure of the brain? or, are we to rest satisfied by asserting that these peculiarities are due to the action of some kind of psychical principle regarding which we know nothing? I have little doubt most will agree that these psychical characteristics of birds depend on peculiarities of brain structure the result of hereditary transmission through many generations. If so, here we have an opportunity of examining the microscopical structure of small brains, relatively simple, and easy of manipulation, with the view of ascertaining whether or not there are any structural differences which will account for these differences in psychical character. This is a line of inquiry likely, in my opinion, to establish an organic basis for a comparative psychology.

After referring to recent researches on the chemistry of the brain, Dr. McKendrick proceeded to refer to those on the physiology of the senses, which afford another series of data for the psychologist. These researches may be said to be of three kinds—(1) inquiries into the anatomical and physiological mechanism of the sense organ itself, such as, in the case of vision, the general structure of the eye as an optical instrument, and its movements by the action of muscles, so as to secure the conditions of monocular or binocular vision; (2) inquiries into the nature of the specific action of the external stimulus upon the terminal organ of sense, and the transmission of the effect to the brain; as, for example, the action of light on the retina, and transmission along the optic nerve; and (3) experiments in which various stimuli are permitted to act under certain conditions on the terminal apparatus, and the result is observed and recorded by the consciousness of the experimentalist himself, as in researches on colour, duration of impressions on the retina, positive and negative after-images, &c. By these three modes of inquiry a large number of facts relating chiefly to the senses of hearing and vision have been collected; and most of these facts, inasmuch as they assist him in understanding the conditions of sensory impressions and sensational effects, are of importance to the psychologist.

Measurement of Time in Sensory Impressions.

The next step of importance made by physiology into the domains of psychology is the measurement of time or duration in sensational effects.[1] This has been carefully measured by objective methods. Speaking generally, the time occupied from the commencement of the action of the stimulus to the termination of a sensation, may be divided into four portions, each of which has a certain psychological interest:—First, an interval of time is occupied by the primary physical change produced by the stimulus. During this interval, called the period of latent stimulation, no effect is observed. Thus, when a motor nerve distributed to a muscle is stimulated by a short electrical shock, about 1-60th of a second passes before the muscle contracts. Second, when the change in the nerve or terminal organ has begun, a second interval of time is occupied in the transmission of the impression to the nerve centre, which is succeeded by a third interval, during which changes occur in the nerve centre, and the result of which is a sensation. The time occupied in transmission, or the rate of conductivity in nerve, is tolerably well known, being at the rate of about 200 feet per second in the nerves of man; but the time occupied in the production of the sensation in the centre has not yet been clearly ascertained, owing to the difficulty of supposing such a sensory nerve centre to be, previous to the stimulus, in a state of absolute inaction. Lastly, it has been found that when a nervous action of any kind has been initiated by a stimulus, it goes on for some time after the stimulus has ceased to act. This prolongation of the sensation may be well studied in the case of impressions on the eye, where the time of the duration of the impression has been measured by Helmholtz, Plateau, and others. These distinguished observers also found that the length of time occupied by the after effect varied according to the intensity of the light. Thus, after a weak light, the unchanged impression lasts longer than with a strong light. A strong illumination is followed by an after impression fading sooner than with a feeble

[1] In the following observations I am much indebted to the essays of Mr. James Sully, contained in his volume, "Sensation and Intuition." (London.)

stimulus; the result being that, so far as the retina is concerned, it comes to the same thing whether an intense light acts for a brief time, or a faint light for a longer time.

Exhaustion of Nerve or Sensory Organ.

This line of research has also made it possible to measure the time required for exhausting a nerve or sensory organ. When, for instance, a limited area of the retina has been stimulated for a certain time, and the stimulus has been removed, the after positive effect, due to increased excitation of the parts, disappears, and is followed by a negative effect, due to temporary diminution of the sensibility of the parts, in the form of what is called the negative after-image. Suppose, for example, an area of the retina be acted upon for a period of from five to ten seconds, and the stimulus be then removed, the so-called positive after-image vanishes quickly, and the negative after-image, frequently of a complementary colour to that of the exciting cause, appears, and lasts for a short time, gradually fading away as the nervous parts recover from the effects of the stimulus. Similar phenomena may be observed in studying the durations of sensations of tone, which I have frequently perceived in experiments made by myself; but it is more difficult to identify, by description and designation, the after effects in the case of audition than in the case of vision. Probably it may be found still more difficult to notice these after sensations in the other senses, although in all there is often the experience of a lingering feeling after the cause has been removed, which no doubt has its place in those transient sensations which assist in filling up the spaces, as it were, in our conscious life.

In experiments upon a sensory organ, such as the retina, a little consideration will show that it is almost impossible to ascertain the effect of a stimulus upon a retina which has never before been affected. This difficulty has been felt by all experimenters. Molecular action in such a structure has been in operation from the very beginning, and such action, if of sufficient intensity, must produce a certain effect on the conducting tract, and on the recipient centre. This effect, although of too weak intensity to produce those changes which result in consciousness, must be taken into account in the measurement of the intensity and duration of sensory impressions. Thus the eye has a light of its own due to changes in the retina, although this may never be conscious to us as a luminous impression. This conception of the state of matters in a terminal organ such as the retina, when applied to actions going on in the brain, at once indicates that similar actions, or rather that similar states of unrest, of change, variation, and modification, are going on in these deeper parts which may never result in consciousness, *per se*, but which altogether may have an influence on our mental existence comparable to that of the feeble impressions constantly transmitted to the cerebrum from the viscera, sometimes termed the internal senses.

Relation between Strength of Sensation and Magnitude of Stimulus.

Having shown that sensory impressions are distinctly related to time, the next advance made by physiologists was to prove that there was a relation between the strength of the sensation and the magnitude of the stimulus. Here there are difficulties in explaining what is meant, because language fails. We have no words to discriminate ideas which hitherto have related to two distinct fields of knowledge—the objective and the subjective. To speak of the strength or magnitude of a sensation seems to be using terms applicable only in another region, and quite inapplicable to psychological phenomena, although no one has any doubt in distinguishing the intensity or magnitude of one pain from that of another. There is no difficulty in understanding the phrase-magnitude of the stimulus. A weight of ten pounds is greater than that of one pound, light from ten candles of equal size is more than that given out by one, and the tones of a violin of equal pitch and quality, may vary in intensity according to the pressure of the bow on the string. It is difficult, however, to obtain an absolute measurement of variations in sensation, which is, of course, a subjective phenomenon. This can only be done by varying the objective cause, by observing a large number of instances, and by expressing variations in the subjective phenomenon in terms applied to variations in the objective cause. If the average result obtained from a large number of instances indicate any ratio between the magnitude of the stimulus and the subjective phenomenon, then we may conclude that there is a relation between the two.

This mode of inquiry, first originated by Prof. E. H. Weber in his celebrated experiments on tactile impressions (and which were first introduced to notice in this country by Prof. Allen Thomson), was afterwards carried out by his colleague Prof. Fechner, and has been subsequently elaborated by Prof. Wundt. It has led to various remarkable results, the chief of which are—(1) That in the case of each sense there is an upper and a lower limit, beyond which the amount of stimulus produces no appreciable difference of effect; and (2) that within this range there is a definite ratio between the stimulus and the amount of the sensation. The upper limit beyond which an increase of external stimulation is not followed by any observable increase in sensational effect, was first observed by Prof. Wundt. The lower limit has been noted by many observers, and it is indicated in almost every physiological text book. Now it does not matter much to us in taking a general view of things, what the limits are, provided we are sure that such limits exist, inasmuch as it indicates another element of proof that psychological phenomena, so far as sensation is concerned, occur within certain physical limits.

Fechner's Investigations.

The next step naturally was to establish the ratio between the magnitude of the stimulus and the magnitude of the sensation. To do this directly is impossible, as any estimation of the amount of sensational effect following a given stimulus would probably be erroneous, because our perceptions are usually qualitative and only rarely, and never absolutely, quantitative. Fechner recognised this fact, and he employed for the solution of the problem various methods by which he measured not sensations themselves, but the amount of discriminative sensibility between two sensations produced by *stimuli* of unequal magnitudes, and he studied the ratio between the difference of weight and the absolute quantity of the stimulation. By varying the amount of the stimulus in every possible way, he eliminated the chances of error, and arrived at definite results. These results he formulated into a general "psycho-physical law," which may be expressed in various ways. Mathematically it may be put, that "sensation increases in proportion to the logarithm of the stimulus." Now "logarithms increase in equal degrees when the numbers so increase that the increment has always the same ratio to the magnitude of the number." It may be put in another way by saying that "the more intense a sensation the greater must be the added or diminished force of stimulation in order that this sensation undergo an appreciable change of intensity." The mode of arriving at some of Fechner's results may be better understood by an experiment which any one can repeat. In the case of muscular sensation, suppose two weights A and B: we wish to ascertain the least difference between these perceptible by the muscular sense, say when we lift them in the hand. Let it be so arranged that both weights are composed of different pieces, so that the one may be made less or more than the other at pleasure. If A and B be nearly equal in absolute weight, the person on whom the experiment is made will judge them to be of equal weight. Let weights be now added to B until the difference between A and B becomes perceptible, and as a test, let the weights be again removed from B until, in sensational effect, A becomes again equal to B; let the same experiment be repeated with weights of different absolute amount, and it will be found that there is a distinct ratio between the absolute weight and the weight that had to be added to it or taken from it to produce the least perceptible difference of impression of whatever these weights may be, up to the limit, of course, which I have already noticed. It will always be found that the additional or subtracted weight is one-third that of the absolute weight—a fraction which indicates the degree of intensity of the stimulus required to produce the lest perceptible feeling of difference of sensation, and may be termed the *constant proportional* of that kind of sensation. This fraction, in the case of sensibility to temperature, Fechner found to be one-third; Renz, Wolf, and Volkmann arrived at the same fraction with regard to auditory impressions; and various observers have found that in visual impressions it is one-hundredth.

Now the intensity of sensation depends on two conditions: (1) the intensity of the excitation; and (2) the degree of excitability of the sensory organ at the moment of excitation. But suppose the excitability of the organ equal on two occasions, the intensity of the sensation does not increase proportionately to the increase of the excitation. That is to say, suppose we bring into a dark chamber a luminous body such as a candle—it produces a certain luminous sensation; then introduce a second, third, and fourth—the excitation is double, triple, or quadruple; but experiment shows that the increase in the amount of the sensation is much less; in other words, let the stimulus increase from 10 to 100 times, and from 100 to 1,000 times, the sensation will be

only one, two, and three times stronger. The importance of the discovery of this remarkable law is, that it shows a distinct mathematical relationship between stimulation and sensation. Possibly it may be found to have applications to other psychological phenomena. May it not vary in different animals, and even in different individuals?

Criticism of Fechner's Method.

It is quite noticeable, however, that in the case of each sense, the law did not hold good throughout the whole range of variations in intensity of stimulus; and it is not surprising, when we consider the complexity of the conditions, that such should be the case. All of these experiments were made in the case of visual impressions, for example, on the living eye, connected by the optic nerve with the brain; and it is manifestly impossible, as has been remarked by Hermann, "to localise this relationship between sensational effect and variation in amount of stimulus, which has been called the psycho-physical law of Fechner." Between the sensational effect and the first contact of the stimulus, there are a series of complicated processes occurring in retina, nerve, and brain, processes undergoing incessant modification by the interchanges between these tissues and the warm circulating blood. In which of these does this relation between stimulus and conscious state occur—in retina, in optic nerve, or in brain? The only method of answering this question, so far as I know, is to examine the effects of stimulation upon these parts separately. It is manifestly next to impossible to do this in the case of the optic nerve and the brain; but by the method pursued by Holmgren, in Sweden, and by Prof. Dewar and myself in this country, it can be done, so far as the retina is concerned. In carrying out this method, Prof. Dewar and I found that light produced a change in the electrical condition of the retina in an eye removed from the head or kept in normal conditions, and we ascertained that the general phenomena of this change corresponded with our sensational experiences of luminous impressions. We were, therefore, entitled to assume that the change in the electrical conditions of the retina, produced by the action of light, might be regarded as a phenomenon intimately related to those changes in the brain which result in consciousness of a luminous impression. Consequently we had an opportunity of ascertaining whether or not Fechner's law agreed with the effects of a stimulus of light in altering the electrical condition of the retina, and we found that it did so. The inference, therefore, is that the relation between degree or variation in stimulus and the corresponding sensation of a luminous impression, is a function of the sense organ or retina.

Mode of Investigating the Sensory Organ Itself.

I may here remark that this mode of inquiring into sensory impressions has by no means been exhausted. The subjective method of observing sensational effect under the stimulus of light from revolving discs, by the contrasting of colours, by comparison of auditory sensations produced by tones of different intensity, pitch, and quality, is always open to the charge that the results may not be due to specific histological structure of the sense organ, as is almost invariably assumed, but to structure of the recipient of impressions from the sense organ, namely, the brain. The only way of proving that the effects are due to structural peculiarities of the sense organ is to examine the effects of stimuli applied to the sense organ separated from the brain by some method the same or analogous to ours. If in these circumstances the sense organ give results similar to those observed in the phenomena of consciousness, then we may assume that these results are due to specific peculiarities of the sense organ, and not to the brain. If, on the other hand, the results do not agree, then we must look in the brain for the mechanism by which these different results are produced. Thus I have always held, that as there is little or no histological evidence of complexity of structure in the retina capable of accounting for the theory of Thomas Young regarding the perception of colours, or of the facts of colour-blindness, or of the sensibility of different zones of the retina to lights of different colours, we may have to look to the complex structure of the corpora quadrigemina, cerebellum, or some portion of the cerebral hemispheres for an explanation of these facts. It may be objected that such scepticism simply removes the difficulty a little further back, but I think it is better to search for facts than to be contented with an hypothesis.

Conclusion.

Time will not permit me to discuss other researches in this field of inquiry, nor the interesting speculations which have sprung from them, but I think I have said enough to show the line of advance in this direction.

True it is that apparently the physiological causation of many mental phenomena may be, in its precise nature, inaccessible to direct proof, but it is our duty as physiologists to push legitimate research as far as it will go. I would remark also that such researches are not incompatible with those spiritual ideas, matters of faith and not of science, which are the basis of our most cherished hopes. They demand, however, caution in the scrutiny of facts, and judgment in drawing conclusions from them. More than in any other kind of scientific labour, perhaps, it is of the utmost importance here to keep the mind unbiassed, a task by no means easy. To maintain a calm unprejudiced attitude to inquiries which seem to demand a change of opinion regarding what was supposed to be final, requires an effort which varies in different persons. Some find it comparatively easy to do so, while others succeed only after a severe struggle. Still it is the state of mind which a man true to science ought to aspire to, so that while he will not be blown about by every wind of doctrine, he may be ready to accept what is apparently true when he has had it clearly put before him.

In conclusion, let me observe that it would save not a little heart-burning, and might possibly remove acrimony from various scientific and social controversies, could we only remember that it is not very probable that we, in this nineteenth century, have arrived at the final solution of many problems which have puzzled wise men from the earliest times. Probably we have got nearer the truth, but it is presumptuous to suppose that we have reached the ultimate truth. Many hypotheses much in favour at present may turn out to be inadequate. Still if they serve as stepping stones to something better, and to more rational conceptions of the mysterious phenomena about us, they will have done good service. In the meantime it is our duty vigorously to prosecute research, in all departments, pushing ahead fearlessly, and with that enthusiasm which is the prime mover in all great deeds, so that we may be able to transmit our department of knowledge to posterity not only less burdened with error, but with many additions of truth.

Prof. Turner, of Edinburgh, gave an account of his researches into the structure of the placenta in mammals, and showed how forms originally supposed to be distinct and unconnected by gradations, were really but modifications of one fundamental type. Thus the obstacle to the reception of the theory of evolution, which had been supposed to be constituted by the various placental structures, did not exist. But it was difficult to see in many respects what causes had determined the evolution. In some cases it appeared that the great dilatation of blood capillaries in the uterus might be of advantage, because less force would be required for the propulsion of the blood. Again, in the upward ascent, there was complication of the placental structures with restriction of area; and he supposed that with this restriction there would be a diminished danger of hæmorrhage after parturition, and consequently greater safety.

Mr. F. M. Balfour, Fellow of Trinity College, Cambridge, read a paper *On the Development of the Protovertebræ and Muscle-plates in Elasmobranch Fishes*. The most important points on which he laid stress were the origin of the notochord from the hypoblast, the splitting of the mesoblast from the hypoblast as two distinct lateral halves, the consequent appearance of the body cavity at first as two cavities, the extension of the body cavity on each side up to the summit of the muscle-plates, and the derivation of a large portion of the voluntary muscular system from the splanchnic or visceral layer of the mesoblast. He compared these embryological facts with many occurring in the Invertebrates, especially in Sagitta, in Brachiopods, and in Echinoderms, showing how it was possible to unify them by adopting Haeckel's gastræa theory, and by no other method. Dr. Allen Thomson warmly commended Mr. Balfour's researches, saying that it was quite a new thing for such a continuous series of embryological papers of great importance to proceed from a British investigator.

Mr. G. J. Romanes, M.A., gave an account of his further researches on the physiological functions of the Medusæ this summer. To this we shall return.

Prof. Haeckel described two of the simplest forms of animals with two layers in their body-wall—Haliphysema and Gastrophysema. They were Cœlelenterata of the simplest type; the first form had one body cavity; in the second it was partly divided into two cavities, whereof one was specially appropriated to the formation of ova, the other to nutrition. If there had

been pores in the body-wall he should have referred both forms to sponges. Their development showed that they arose strictly in conformity with the Gastræa type. He then gave some account of the mode of development of the chief animal stocks, as explained in the "History of Creation." Dr. Allen Thomson said that Prof. Haeckel had been regarded in many quarters with somewhat of the same suspicion that had greeted the first promulgation of Mr. Darwin's theories, and he was considered one of the most rash and daring speculators of the day. Those who had listened to his exposition would probably take a different view, and see how much of sound observation went to the establishment of his theories. In so extensive a field as that over which Prof. Haeckel's views carried him, he might be sometimes led into error, and might possibly be widely wrong, but at the same time they could not but admire the manner in which observation of fact was always placed as the basis of his theory.

Dr. D. J. Cunningham read a paper *On the Spinal Nervous System of the Cetacea*. He found that while great similarity prevailed between their cervical and dorsal nerves and those of other mammalia, the nerves of the lumbar and caudal regions differed widely. The superior and inferior divisions of those nerves in cetacea were of nearly equal size. Two great longitudinal cords or trunks are formed by their union on each side of the vertebral column, and these become situated on either side of the spines of the vertebræ, and on either side of the bodies below the transverse processes. These great cords supply the four great muscular masses which act upon the tail.

Prof. Burdon-Sanderson gave an account of his further researches *On the Electrical Phenomena exhibited by Dionæa muscipula* (*the Fly-trap*). He had accurately investigated the phenomena by means of the electrometer. He found that normally the whole leaf with the petiole was somewhat negative, but that when excited by a stimulus, an electrical change took place throughout, making every part more negative; the greatest change was on the external surface of the leaf immediately opposite to the three sensitive hairs. There was no relation between the pre-existing currents and the electrical disturbance consequent on stimulation. The period of latent stimulation was about one-sixth of a second; the period during which the disturbance lasted was one second, more or less. As the leaf becomes fatigued, the period of latency gradually increases to one second and three-quarters, and then most likely the next stimulation would produce no effect. The change appears to be a function of the protoplasm of the parenchyma of the region out of which the sensitive hairs arise. Certain of the characters of the change are similar to those presented by muscle and nerve. Why the variation should be a negative one, Prof. Sanderson had no idea.

Prof. Struthers described the finger-muscles of several whales. He concluded that such muscles existed in the whalebone whales, but in ordinary teethed whales they were merely represented by fibrous tissue. These muscles existing in the true bottle-nosed whale had a special interest, as the teeth in that whale were rudimentary and functionless. He had found these muscles in the forearms of whales largely mixed with fibrous tissue, so the transition was easy. He also gave an account of dissections of the rudimentary hind-limb of the Greenland right-whale. Prof. Macalister, of Dublin, expressed his opinion that the whales were not of very ancient origin, for he thought the existence of the rudimentary limbs tended to show that a sufficient length of time had not elapsed since the use of the limb was essential to the earlier animal, to produce its complete obliteration.

Mr. C. T. Kingzett read a paper *On the Action of Alcohol on the Brain*. He said the question of what became of alcohol taken into the system had been extensively studied. Thudichum was the first to determine quantitatively the amount of alcohol eliminated by the kidneys from a given quantity administered, and the result he obtained was sufficient to disprove the elimination theory then widely prevailing. Dupre and many others continued these researches from which, according to Dupre, they might fairly draw three conclusions: (1) that the amount of alcohol eliminated per day did not increase with the continuance of the alcoholic diet, therefore all the alcohol consumed daily must of necessity be disposed of daily, and as it was certainly not eliminated within that time it must be destroyed in the system; (2) that the elimination of alcohol following the taking of a dose was completed twenty-four hours after the dose was taken; and (3) that the amount eliminated in both breath and urine was a minute fraction only of the amount of alcohol taken. In 1839 Dr. Percy published a research on the presence of alcohol in the ventricles of the brain, and, indeed, he concluded "that a kind of affinity existed between the alcohol and the cerebral matter." He further stated that he was able to procure a much larger proportion of alcohol from the brain than from a greater quantity of blood than could possibly be present within the cranium of the animal upon which he operated. Dr. Marcet, in a paper read before the British Association in 1859, detailed physiological experiments which he considered to substantiate the conclusions of Dr. Percy, inasmuch as they demonstrated that the alcohol acted by means of absorption on the nervous centres. Lallemand, Perrin, and Duroy had, moreover, succeeded previously in extracting alcohol from brain-matter in cases of alcoholic poisoning. But all these researches left them entirely in the dark as regarded the true action, if any, of alcohol on cerebral matter, and no method of investigation was possible until the chemical constitution of the brain was known. Thudichum's researches in this direction, together with some more recent and published investigations by Thudichum and the author, had placed within reach new methods of inquiry regarding the action of alcohol on the brain. In his research he (Mr. Kingzett) had attempted this inquiry by maintaining the brains of oxen at the temperature of the blood, in water, or in water containing known amounts of alcohol. The extracts thus obtained had been studied in various ways, and submitted to quantitative analysis, while the influences exerted by the various fluids on the brain had been also studied. These influences extended in certain cases to hardening and to an alteration in the specific gravity of the brain-matter. Water itself had a strong action on brain matter (after death) for it was capable of dissolving certain principles from the brain. It was notable that water, however, dissolved no kephaline from the brain. Alcohol seemed to have no more chemical effect on the brain than water itself, so long as its proportion to the total volume of fluid did not exceed a given extent. The limit would appear to exist somewhere near a fluid containing 35 per cent. of alcohol. But if the percentage of alcohol exceeded this amount, then not only a larger quantity of matter was dissolved from the brain, but that matter included kephaline. Such alcoholic solutions also decreased to about the same extent as water the specific gravity of brain substance, but not from the same cause; that was to say, not merely by the loss of substance and swelling, but by the fixation of water. Many difficulties surrounded the attempt to follow these ideas into life, and to comprehend in what way these modes of action of water and alcohol on the brain might be influenced by the other matters present in blood. On the other hand, it was difficult to see how any of the matters known to exist in the blood could prevent alcohol, if present in sufficient amount, from either hardening the brain (as it did after death) or dissolving traces of its peculiar principles to be carried away in the circulation; that was to say, should physiological research confirm the stated fact that the brain in life absorbed alcohol and retained it, it would almost follow of necessity that the alcohol would act as he had indicated and produce disease, perhaps *delirium tremens*. Dr. McKendrick said Mr. Kingzett's researches into the chemistry of the brain and the action of various agents upon it were a valuable step in the right direction. This was essential if the mode of working of the brain were ever to be understood; but it would be a long way from the knowledge of the dead tissue to the comprehension of its vital action. No doubt alcohol had a marked effect upon the convective-tissue elements in the brain. He suggested as a useful method of research the submitting a certain class of animals for a length of time to the action of a definite amount of alcohol, and then examining their brains to discover what effect was produced. The investigation was of very great importance as regarded the treatment of drunkards; no doubt in many cases where it was thought that they had to do with merely moral evil, there was a fundamental change in physical organisation. Prof. Burdon-Sanderson said the question was one that ought certainly to be taken up by Government, and the best men in the country should be engaged upon the inquiry. It had a most important bearing upon the welfare of the community and the diminution of human suffering.

Surgeon-Major Johnston, in a paper *On the Diet of the Natives of India*, came to the conclusion that the natives require much more nitrogen and carbon than Europeans, and also took much more salt, owing to the comparative absence of salt from the substances which form a large part of their food. The natives took more dry food than the Europeans, and those who lived on food from the tables of the Europeans enjoyed a considerably greater immunity from cholera than others.

Mr. Wanklyn read a paper *On the Effects of the Mineral Sub-*

stances in Drinking-Water on the Health of the Community. One of the questions which has often been asked is, Whether is it better to drink hard water or soft water? The reply which has been given is that at present we cannot tell, but that apparently the system can accommodate itself to either, and that a soft-water drinker is sometimes disordered when he begins to drink hard water. He wished to call attention to the opportunity that physicians had at present of discovering the effects of hard waters by reason of the great use that was being made of a very hard water, the Tannus water. Ordinary hard water might contain from 13 to 20 grains of carbonate of lime per gallon; but the Tannus water contained, roughly speaking, 100 grains of carbonate of lime and 200 grains of common salt per gallon, besides considerable quantities of carbonate of magnesia, chloride of potassium, and sulphate of soda. In the course of the discussion which followed the reading of Mr. Wanklyn's paper, Dr. Carr stated that in Kent, where the water was hard, he believed the amount of salts of lime was exceedingly beneficial to children, and the Kentish children were singularly well supplied with straight legs and good bones. Mr. Wanklyn stated that Kent water was one of the purest he had ever seen; average drinking-water contained ten times as much organic matter as the Kent water. The real objection to the latter was that it contained a large proportion of sulphate of lime; whenever it was met with in any volume it had something of the odour of rotten eggs, due to the presence of sulphuretted hydrogen and sulphate of lime. He questioned whether hard water, however useful for children, was altogether desirable at a later period of life.

Dr. Paton's able paper *On the Action and Sounds of the Heart* gave an account of excellent experimental researches, by which he claimed to have proved that the ventricle in coming to complete contraction itself exerts a strain on the base of the distended aorta that produces the simultaneous reaction of the aorta, closing the valves and completing the wave. This is contrary to the usual view which considers that the aorta reacts after the conclusion of the ventricular contraction. The influence of this new conception on the comprehension of the sounds of the heart is important; for if a sound be produced in closing the semilunar valves, it must terminate the first sound of the heart, and cannot be the second sound. The latter arises after the first pulse-wave has terminated, and is synchronous with the diastole of the ventricle. In a series of experiments on the action of the denuded heart of the terrapene during the highest temperature of the season, when the action of the heart was strong and vigorous, Dr. Paton distinctly identified the first sound with the contraction of the ventricle and the reaction of the aorta, the sound being produced by the rushing of the blood through the orifice and terminated by the recoil of the aorta. The second sound, short, sharp, and acute, was produced by the contraction of the auricles sending the blood through the auriculo-ventricular orifices. The effect of these facts upon pathological sounds was followed out.

Among other contributions to this department may be mentioned Prof. Dewar's continuation of his important researches *On the Physiological Action of Light*, Dr. Urban Pritchard's paper *On the Termination of the Nerves in the Vestibule and Semicircular Canals of the Ear of Mammals*, and the same author's *Demonstration of a New Microscope adapted for showing the Circulation in Man.*

The five days' session of this department was fruitful in important memoirs on physiology, anatomy, embryology, and histology, showing that a considerable amount of good work is going on in this country. The discussions were of more than usual value, as many eminent anatomists and physiologists were present and took part in them.

Department of Zoology and Botany.

Among the botanical contributions was an interesting one by Dr. I. B. Balfour, entitled *Notes on Mascarene Species of Pandanus.* He said that no portion of the flora of the Mascarene Islands was more peculiar than the various species of the genus Pandanus, or screw Pines. There were many species endemic to the islands, but many species were found all over India, and they also extended into China and other places in the Malay Archipelago, and a few species were to be found in Australia. Of the twenty-two species which occurred in the Mascarene Islands, twenty were endemic to the islands; their generic characters were exceedingly well marked, and the definition of species was a very difficult matter. An investigation of the whole genus was very much wanted, but this had hitherto been rendered difficult by the want of knowledge of the Mascarene species. The descriptions of the first author who wrote anything about these Mascarene species were exceedingly short, and just now the confusion in regard to the whole genus was something extraordinary. There were nine species at least endemic to the Mauritius, and in the Bourbon they had record of four distinct species, three of which were peculiar to the island. He had examined the fruits and leaves of these plants, but the leaves afforded very few characters. They were diœcious plants, and the male flowers would furnish them with very good characters for distinction. Three species had been grouped together by their carpels never or at least very rarely being united. Two of these were endemic to Mauritius, and one to Bourbon.

Prof. W. C. Williamson gave an address on his recent researches on the structure of the coal plants, especially Calamites, Lepidodendron, and Sigillaria. He considered that the accurate determination of the true nature of each of the coal plants was of the utmost importance to the theory of evolution. He combated the view which would divide the genus Calamites into two, Calamites and Calamodendron. He described some new forms of lepidostrobi or cone-fruits of fossil lycopods, and concluded by showing the remarkable tendency of many of these coal plants to develop into a very uniform type, making it almost impossible to identify small fragments either of their wood or of their bark. Hence it was absurd to attempt to establish genera and species upon such unrecognisable fragments.

Mr. C. W. Peach read a paper *On Circinate Vernation of Sphenopteris affinis, and on the Discovery of Staphylopteris in British Rocks.* Mr. Peach has found *Sphenopteris affinis* in the black shale at West Calder, near Edinburgh, in a series of specimens showing its vernation from the earliest stage till the complete development of the plant; he believed that other observers had described several species of Sphenopteris from this one form in its various stages. The genus Staphylopteris, which he had also found at West Calder, was well known as occurring in the carboniferous rocks of Illinois and Arkansas. Prof. McNab gave an account of the structure of the leaves in several species of Abies (larches), which will be fully illustrated in the *Proceedings* of the Royal Irish Academy.

Prof. Leith Adams described the fossil remains of the Maltese caves, with especial reference to the gigantic land-tortoises, similar to those of the Galapagos and Mascarene Islands, but much larger still. Nevertheless they were very much alike in osteology, so that there had been great difficulty in determining that the species were distinct. Another notable animal was a dormouse as large as a guinea-pig, so numerous that five or six specimens could be obtained out of one spadeful of mould. Among the fossil-birds was a swan one-third larger than any modern one. Altogether 150 terrestrial vertebrates had been found in Malta, and it was impossible that they could have lived in that locality unless Malta was part of a continent.

Mr. Spence Bate, in continuing his report on the structure of the Crustacea, dealt especially with the eyes, pointing out that these organs were in some cases covered by, and received support from, the carapace, and in others they were supported by a jointed peduncle. The chief modifications of the appendages of the head were examined, and they led Mr. Spence Bate to the conclusion that the seven sections of which the head was composed should be regarded as completely different from the other parts of the body.

Dr. W. B. Carpenter reported the result of further researches *On the Nervous System of Antedon (Comatula) rosaceus*, and also read a paper by his son, Mr. P. H. Carpenter, *On the Anatomy of the Arms of Crinoids.* He maintained that the tract of tissue in the axis of the arms, by which motor impulses were conveyed to the arm-muscles, was equivalent to a nerve, although it did not present the microscopic structure of nerve-fibres.

Dr. D. J. Cunningham read a paper *On a Specimen of Delphinus albirostris* which he had procured this spring. Prof. Cohn, of Breslau, made a number of beautiful experiments to show the artificial formation of silica shells.

Prof. Young gave a description of the novel arrangements adopted by him in the new Hunterian Museum. The cases were arranged so that visitors could walk around them on the outside while curators or students were at work upon them on the inside. The cases were to contain skins, skeletons, soft parts, and fossil remains in close proximity, so that the whole of what was known about one series of forms might be brought together, instead of being scattered as usual. The fittings had been made with great skill by Messrs. D. and T. Robertson of Glasgow.

A discussion on spontaneous generation arose on a paper by Dr. Carmichael, of Glasgow, entitled *Spontaneous Evolution*

and the Germ Theory. Dr. Carmichael had made a considerable series of experiments, the results of which were generally confirmatory of those of Dallinger and Drysdale, and of Tyndall. Prof. G. S. Boulger read a paper *On Sex in Plants*, giving a comprehensive view of recently-acquired knowledge on the subject.

This department certainly did not produce papers ranging over more than a small portion of the field allotted to it. Some contributions of high merit were made, but in many departments of natural history no sign was made that any work was going on in the British Isles.

Department of Anthropology.

Mr. James Shaw read a paper *On Righthandedness*, expressing the opinion that there was a constitutional reason for the greater use of the right hand. Lefthandedness seemed very mysterious physiologically; it must be far more common than transposition of the viscera which had been supposed to account for it. In several cases of transposition of the viscera, the persons affected had been found to be right-handed. Another paper by Mr. Shaw was *On the Mental Progress of Animals during the Human Period*. In the discussion which followed Dr. Grierson mentioned an instance of intelligence which had come under his own notice. Five years ago a barrel was put up in his garden at the top of a high pole. The barrel was perforated with holes and divided in the centre. In the course of two days two starlings visited the barrel, and returned on the following day, and in about a week afterwards two pairs of starlings came and occupied it, and brought up their young. They were very wild starlings, and readily took flight when any person went near the barrel. In the second year four pairs of starlings occupied the barrel, and they were much tamer than the previous ones, and this last year there were a number of pairs of starlings so tame that they would almost allow him to take hold of them. They had now changed their mode of speaking, for the starlings in his garden frequently articulated words.

Mr. Hyde Clarke read a paper *On the Prehistoric Names of Men, Monkeys, and Lizards*, tending to prove that in early times and by some savage races at the present day, every word which was used as distinctive of man was likewise applied to other animals, but only to those which used their fore feet as hands, or in a distinctive manner. A paper contributed by Herr von Humboldt von der Horck was read by Mr. Hyde Clarke. The author was in charge of an expedition to the polar seas, and sent an account of the Laplanders and people of the north of Europe. He divided the Lapps into the nomadic or mountaineers, and the sea or fish Lapps. The nomads were stronger, healthier, and better developed, and rarely intermarried with the Finns or the Norwegian settlers.

Mr. Hyde Clarke's researches *On the Relations between the Hittite, Canaanite, and Etruscan Peoples and the Early Peruvians and Mexicans* were laid before the department. He believes that they really belong to one family, representing an early culture which became arrested. They had little community with the Semitic or Aryan types. Mr. J. Park Harrison dealt with the origin and meaning of the "Picture Writing" of Easter Island. He said that many of the tablets were gradually getting destroyed, and he called attention to the desirability of acquiring as many of them as possible, and of instituting a careful ethnographical exploration of Easter Island.

Mr. Bertram F. Hartshorne, late of H.M. Ceylon Civil Service, read a paper entitled *The Rodiyas of Ceylon*. The people treated of in his paper were a numerically small race, living in various isolated communities in the hill country of Ceylon. Their caste is the very lowest, and they have from time immemorial been regarded by the Singhalese people with disgust and abhorrence, their very name implying the notion of filth. The popular belief has commonly considered them to be either in some way connected with the Weddas, an aboriginal race of the highest caste, or else to be outcast Singhalese or ostracised Kandyans. There appears, however, to be no real ground whatever for either of these theories—the features of the Rodiyas, as well as their general *physique* and their craniology, marking them out as a separate and distinct race, no less than their customs and language. Their customs are distinguished by peculiar funeral ceremonies, and by sacrifices offered to two sorts of devils in cases of serious sickness; and their language, which is now in one of the last stages of decay, is of unknown origin and development, and can neither be classified as Aryan nor Dravidian. In all probability it represents the remnants of a more complete and extremely ancient language, although it possesses no separate alphabet, nor any literature. The earliest historical mention of the Rodiyas apparently occurs in the year 437 B.C., and they are expressly referred to by name in the year 204 B.C., and again in the year 589 A.D. in the ancient Singhalese chronicles. The condition of the people, however, has at all times been degraded, notwithstanding the fact that the males are invariably possessed of a fine *physique*, and the females are considered to be handsome. The peculiar social disabilities which have been imposed upon the Rodiyas by the uses of ages are now rapidly disappearing with the advance of civilisation, whilst at the same time the idiosyncrasy of the people themselves as well as their customs and their language, is gradually becoming merged in the more modern type of their Singhalese surroundings. The president (Mr. Wallace), in moving a vote of thanks to Mr. Hartshorne, said the Rodiyas were a race of people who, though in a degraded condition, yet possessed physical characters which seemed to show they were intellectually superior to the races who treated them in this manner. This might be another of those examples to which he alluded in his address, of a remnant very fast dying out—a remnant of one of those early higher races which had been overrun and overcome by a lower race intellectually, but more energetic, and had been reduced to an extremely degraded position. It was also a valuable example proving that degradation long continued did not alter to any great extent the physical features of the race. Though they had been for ages in this degraded condition they retained a fine type of face, almost equal to many European forms.

Mr. William Harper contributed a paper *On the Natives of British Guiana*, who were generally said to belong to five tribes, namely, the Arawacks, the Caribs, the Accawoi, the Macuri, and the Warans. Representatives of several other tribes were, however, frequently met with on British soil. These people were merely remnants of a few barbarous tribes found, for the most part, between the Amazon and the Orinoco. It was extremely difficult to obtain any information as to the origin of these tribes; and the general result of the author's investigations was that, though it did not now admit of proof, it was very probable that all the Brasilio-Guarani tribes came from the north, though not at the same time. Of the tribes in British Guiana, the Warans and Macuri had probably been longer in the country than the Caribs, Accawoi, and Arawacks. These tribes differed a good deal from one another in their language, characteristics, and habits, but not in their outward appearance or mode of living. The author suggested that light might be thrown on the origin of these tribes by collecting fac-similes of the rock-writing to be found among them, and comparing them with similar writing to be found in other parts of America, especially in the valley of the Mississippi.

Mr. Kerry Nichols read a paper *On the New Hebrides, Banks, and Santa Cruz Islands*. The natives inhabiting these islands seemed to owe their origin to the same stock from which the western and southern portion of New Guinea and the islands lying immediately to the southward of that country appear to have been peopled. The stock was evidently Papuan, and had, by its numerous and wide-spreading branches, not only extended itself over the islands of the coral sea, but as far east as the Fijis, in which latter country, however, the race had evidently received a great infusion of Malay blood. Whatever opinion might be formed on the identity of the present race, the striking resemblance in person, feature, language, and customs which prevailed throughout, justified the conclusion that the original population issued from the same source, and that the peculiarities and characteristics which distinguish the tribes or communities on different islands had been mainly brought about by long separation, local circumstances, and the intercourse of foreign traders and settlers. Physically considered, these people were a well-built, athletic race of savages, who appeared to inherit, in a very marked degree, all the characteristics of the Papuan race. The men average about 5 feet 6 inches in height, are erect in figure, with broad chests and massive limbs, which in many instances display great muscular development. The colour of the skin was usually of a dark reddish brown, but sometimes it was quite black, and was often covered with a short, curly hair, especially about the breast, back, and shoulders. He saw several instances in the Island of Tanna where the body was almost completely covered in this way. They had well-formed heads, the cranium in the majority of instances betokening a fair degree of mental development. The hair, which formed one of the most remarkable features of this race, was distributed thickly over the head in the form of small spiral curls, and when allowed to grow in its natural way

had a woolly appearance, and resembled at first glance that of the African negro, but it was in reality much finer and softer. The beard was worn short, and usually trimmed, with a tuft beneath the chin. They shave with the teeth of the shark, an oyster shell, or a piece of bottle glass, and perform the operation with the skill of accomplished barbers. In the northern islands the men went completely naked; but in the southern islands, where the climate was slightly cooler, they affected a scant covering, after the fashion of the primitive fig-leaf. They were fond of decorating the head with flowers and feathers, and of tattooing the face with red and blue pigments, which imparted to them a savage and ferocious look. All things considered, the physical condition of the islanders did not appear to manifest any sign of degeneration. A very complete account of the social and intellectual condition of these islanders was given. The slight idea of religion possessed by the islanders might be described as the most primitive form of Paganism. On some of the islands they worshipped rude idols of wood, while in others they seemed to put implicit faith in imaginary gods who were supposed to inhabit the highest mountain tops. The dread of evil spirits and demons was universal among them. The natives of each island had a distinctive dialect of their own, and even the various tribes inhabiting each island had also distinct and separate dialects.

Mr. W. Pengelly, F.R.S., gave an account of the contents of an urn which had been found in a field near Chudleigh in Devonshire. The urn contained a large number of pieces of pottery supposed to be Roman, and a number of calcined bones which were the bones of goats or sheep. This was the only occasion, as far as he knew, in which the bones of animals had been found in such urns.

Dr. Knox read a paper *On Bosjes Skulls.* One of his specimens had a capacity of only sixty-four cubic inches; the longest measured seventy-four cubic inches. The skulls belonged to the long-headed type, though not of the longest. The skeleton to which one of the skulls belonged, was remarkable for the wedge-like shape of the pelvic bone, which was also very deep.

Dr. Allen Thomson exhibited and described two skulls from the Andaman Isles; and referred to the custom the natives had of preserving portions of their friends' skeletons and wearing them as ornaments. The skulls of their husbands were actually worn upon the shoulders of widows.—Prof. Cleland described the skull of a Sooloo Islander.—Dr. McCann, in a paper *On the Origin of Instinct*, brought forward well-known objections to Mr. Darwin's explanations, referring to the descent of bees, the first birds hatching eggs, &c.

Nearly the whole of one day was occupied by the reading of a paper by Prof. Barrett, of Dublin, *On some Phenomena Associated with Abnormal Conditions of Mind*, on which an excited discussion arose. Many phenomena of mesmerism, clairvoyance, and spiritualism were alleged, and Mr. Crookes, Mr. Wallace, Lord Rayleigh, and Dr. Carpenter expressed opinions which are well known, based on facts witnessed by themselves.

The work done in this department does not compare well with the result at Bristol last year. Scarcely anything of importance was brought forward in prehistoric anthropology. Some good accounts of savage tribes of the present day were given; but otherwise the scientific value of the department is this year comparatively small. The concluding portion of Mr. Wallace's presidential address is perhaps the most noteworthy feature in anthropology, as exhibited at Glasgow.

SECTION E.—GEOGRAPHY.

There were an unusual number of papers of general interest and importance in this as well as in Sections F. and G., and we therefore regret that our space does not permit of reporting them at length.

Mr. Octavius Stone read a paper *On his Recent Journeys in New Guinea.* The island, he said, extended in a south-easterly direction for a distance of over 1,400 miles, having a maximum width of 450 miles and a minimum of only 20. The neighbourhood of the Baxter River and the entire shores to the west of the Papuan Gulf for an average of 100 miles inland were low and more or less swampy, being intersected by water-courses and covered with forests of mangrove trees. This part of the country was thinly populated by the Dandé Papuans, who in consequence were subjected to periodical raids from the adjoining islands of Borga, Saibai, and Daun, the invaders generally returning victorious with the heads or jawbones of their slaughtered victims. The only trace of cultivation he saw was 80 miles up the river, where a space of six acres had been neatly fenced round, and planted with yams, taros, sugar-cane, and tobacco. Outside the inclosure were two or three uninhabited bark huts, which appeared to afford shelter to these roving people, in which they prolonged their stay, as game was more or less plentiful. Traces of wild boar and kangaroo were observed in the Upper Baxter. No other large animal was known to exist. They were hunted with the bow and barbed arrow, while the war arrows were poisoned by steeping in the putrid carcase of a victim until sufficiently saturated. The district of the Baxter River contrasted strikingly with the Fly River discovered by Capt. Evans, whose banks for sixty miles swarmed with human beings. Mr. Stone's impression of the western coast was that it would prove a grave to such Europeans as should choose to reside there. This part of the country was inhabited by the Papuan race, a dark race of people, though not so dark as the Australian negro, and one of cannibal propensities. The Eastern Peninsula, on the other hand, was inhabited by the Malay race. Of this race Mr. Stone thought they had come to New Guinea from islands farther east, some of them making the change at a comparatively recent date. This race was far above the savage, both in intellectual and moral attributes. They were cultivators of the soil—each having his own plantation—and strongly opposed to the cannibalism and polygamy which obtained among their western neighbours, the Papuans. The women, too, of the Malay race were not debased as among the dark race, but mixed with the men, with whom they shared the management of public affairs. The Owen Stanley mountains ran through the centre of the country, from south to north, and the east country was on the whole favourable to cultivation, and probably possessed great mineral wealth. It accordingly offered sufficient inducement for colonisation, but colonisation, if attempted, would require to be set about with much previous consideration, owing to the peculiar situation of the peninsula and the circumstances of the people.

Mr. Kerry Nicholls read a paper *On the Islands of the Coral Sea*, which embraces that portion of the Pacific Ocean extending from the south of New Guinea, westward to the coast of Australia, southward to New Caledonia, and eastward to the New Hebrides. The New Hebrides' banks and Santa Cruz Islands, he said, constitute an almost continuous chain of fertile volcanic islands, extending for a distance of 700 miles, between the parallels of 9° 45′, and 20° 16′ south latitude, and the meridians of 165° 40′, and 170° 33′ east longitude. Espiritu Santo, the largest island of the archipelago was seventy-five miles long, and forty miles broad. The geological formation of the islands was composed of volcanic and sedimentary rocks. The chain of primary volcanic upheaval might be traced running in a general course longitudinally through the islands always in their longest direction, the axis of eruption being marked by active and quiescent volcanoes. On the north end of the island of Vanu Lava there were extensive springs of boiling water, solfataros, and fumaroles. The hot springs were of two kinds—some were permanent fountains where water was in a constant state of ebullition, others were only intermittent, and the water became heated at certain intervals, when it varied from a tepid degree of heat to boiling point. The physical features of the islands were remarkably bold, and betokened at first sight their volcanic origin. The plains, table lands, and valleys of the mountain region were, many of them, of considerable extent.

Capt. V. L. Cameron, R.N., C.B., read a paper *On his Journey through Equatorial Africa.* Capt. Cameron said that soon after entering the country from the east coast he came to a large plateau, 4,000 feet in height, encircling Lake Tanganyika, and forming the water-shed between the Congo and the streams flowing into Lake Sangora. Another table-land to the south rose to the height of 3,000 feet. The water-shed between the two basins of the Lualaba and the Congo at that part is a large, nearly level country, and during the rainy season the floods cover the ground between the two rivers, and a great portion of it might easily be made navigable. One thing he noticed in Africa was this system of water-sheds, dividing the country into portions, each having its own peculiarity, and also that in each there was a difference in the habits of the natives. Within twenty days he crossed the Nsagara Mountains and came upon a level open country where a great quantity of African corn was grown, the stalks of which rose to the height of from 20 to 24 feet. In this country no animal could live except the goat, the tsetse fly being destructive to all others. The principal geological formation was sandstone. A few marches brought him to Ugogo, an extensive plain broken by two ranges of hills, composed of loose masses of

granite piled together in the wildest confusion. The soil was sandy and sterile. Coming to the country of the Ugari he found a tribe almost identical with Unyamwesi. The principal streams of this district fall into the Mulgarazi. Unyamwesi was the commencement of the basin of the Congo. He believed that the natives of Unyamwesi were of the Malay race. They had crossed a great deal with negroes, and had lost the distinctive colour and distinctive marks of the race, but their features were much the same as the dominant races in Madagascar Ugaro is a large plain nearly as flat as a billiard table. The people here were different from the Unyamwesians; they had not got the same features or the same tribal marks. After passing over the mountains of Komendi, which are an offshoot of the mountains round the south end of Tanganyika, they came to a fertile land, much of it laid waste by the ravages of a neighbouring tribe. All the mountains in that district were of granite. There was there a large quantity of salt and what was remarkable was that the rivers ran perfectly fresh through soil which, when the natives dug wells, gave water which was full of salt. At Ujiji the people are of a different race from those already described, as they shave their hair differently and have not the same features. Along Lake Tanganyika in some places there were enormous cliffs and hollows of rugged granite lying in loose boulders; in other places the cliffs were of red sandstone, and in others a sort of limestone and dolamite. At one place he saw exposed on the shores of the lake large masses of coal. Passing down to the south end of the lake, he found it regularly embedded in cliffs 500 to 600 feet high, with waterfalls discharging themselves down the face. Travelling along the side of the lake he came to the Lukogo, a large river more than a mile wide, but partly closed by a sort of sill on which a floating vegetation was growing, a clear passage, however, being left of about 800 yards. After proceeding some four miles up the river, Capt. Cameron's boat got jammed amongst the floating vegetation which grows to the thickness of two or three feet, and it was with difficulty the boat was extricated. The Kasongo country was next reached, the principal characteristic of which was the extraordinary trees, of which boats a fathom wide are sometimes made Crossing the mountains of Bambara he arrived at Mamyuemba. Here he found the race entirely different from anything he had yet seen. The houses were differently built, the people were differently armed, dressed their head differently, and there was no tattooing to speak of. The villages were built in long streets thirty or forty yards wide, two or three streets being alongside each other, and a space left between the houses, which were of reddish clay with sloping thatched roof—the only houses of that description he saw in the interior of the country. All the Mamyuemba are cannibals. Journeying northwards, but still in Mamyuemba, a district was reached where iron was very plentiful, and where large forges were at work. Many of the spears and knives which they turned out looked as if finished off by a file or polished by some means, although all done by hand-forging and patient labour. The Lualaba River was next reached, which is about 1,800 yards in breadth. The southern shore is occupied by a tribe called the Wagenga, who do the whole carrying business of the river, being the only canoe proprietors, who take for pay the products of the country to the different markets. The young women make immense quantities of pottery in the mud and back water, which they exchange for fish. After referring to a country between Nywangi and Loami, where a palm oil grows in great profusion, Capt. Cameron passed through Kilemba, and reached Lake Kigongo. This lake is covered with floating vegetation, on which the people build their houses, cut a space round about them, and so transform their habitations into floating islands, so that when desirable they change the locality from one place to another.

most magnificent

climate in which a

been settled in this neighbourhood for thirty years. The whole of this country was just one vast slave field. In the country there was a vast mineral wealth and an ordinary population that with education might be rendered very industrious instead of carrying on a continual warfare against each other for the purpose of obtaining slaves.

An interesting discussion followed.

Col. R. L. Playfair, H.M.'s Consul-General in Algeria, read a paper *On Travels in Tunis in the Footsteps of Bruce.* The paper gave a narrative of the Colonel's observations made in the course of a journey in Tunis over places visited by Bruce about 1763. There had been recently put into Col. Playfair's hand for publication a large number of Bruce's sketches, of which his Barbary sketches were, he said, the most interesting, forming about 120 sheets of drawings, completely illustrating the archæology of North Africa. In these circumstances, the Colonel had determined to follow Bruce in his journey, and to satisfy himself as to the present condition of those interesting ruins which were almost unknown to the modern traveller.

Mr. A. Bourden read a paper, the object of which was to show that ready access could be had to the Niger and the African interior from Sierra Leone.

The Secretary, in the absence of the author, read a paper by Lieut. W. H. Chippindall, R.E., containing *Observations on the White Nile between Gondokoro and Apuddo.* The object of the paper was to establish Lieut. Chippindall's opinion that the oft-repeated assertion that the White Nile could not be navigated higher up than Gondokoro had no warrant in fact. He was sure the White Nile was navigable all the way up to the Albert Nyanza.

A paper was read by Staff-Commander Tizzard, R.N., *On the Temperature obtained in the Atlantic Ocean, during the Cruise of H.M.S. "Challenger."* Over a great portion of the Atlantic the bottom temperature has this peculiarity —If the depth be less than 2,000 fathoms, we find the temperature at the bottom lower than that of any intermediate depth, but when the depth exceeds 2,000 fathoms, we find that the bottom temperatures are nearly the same as they are at that depth. This holds good for three-fourths of this ocean. In the remaining fourth the temperature obtained at the bottom is much lower than in the other parts, and this fourth is not at either extreme, where there is a large current of surface cold, but occupies the whole of the western portion of the South Atlantic as far north as the Equator. The results of these temperatures may be classified thus: If an imaginary line be drawn from French Guiana to the westernmost island of the Azores and from thence north on the western side of this line, the bottom temperatures at depths exceeding 2,000 fathoms are 35 degrees—that is, taking the mean of all the temperatures obtained which differ but slightly. On the eastern side of this line the bottom temperatures are 35·3 deg., and this uniform temperature appears to extend as far south as Tristan d'Acunha, as the German frigate *Gazelle* obtained similar bottom temperatures eastward of the line joining that island with Ascension to the southward of a line joining Tristan d'Acunha with the Cape of Good Hope. The bottom temperatures are decidedly colder between the eastern coast of South America and a line joining Tristan d'Acunha and Ascension Island; and from the Equator to the southward the bottom temperatures were invariably colder than at any intermediate depth. These temperatures varied from 31 deg. to 33 deg. 5 sec., that is when the depth exceeds 2,000 fathoms, and temperatures of less than 33 deg. were found as far north as the Equator, while a few miles northward this bottom temperature was 35 deg. It therefore appears that in the western portion of the South Atlantic the highest bottom temperature is less than the lowest obtained elsewhere in this ocean, excepting where the very low result of 29 was found by the *Porcupine* in 1869 between the Faroe Isles and the north extreme of Scotland. The question thus arises as to the causes which confines this cold water to the bottom portion of the western half of the South Atlantic. The examination of the soundings which had been taken in this ocean, combined with the results of their temperature, leads to the conclusion that there is a series of ridges dividing its bed into two basins, one of which occupies the whole of the western portion of the North Atlantic, while the other extends the whole of the length of the ocean on its eastern side, and that the cold water in the western portion of the South Atlantic is owing to there being no obstruc-

1,950 or 2,000 fathoms in depth. To ascertain the thermal condition of the Atlantic (from the surface to the bottom), serial temperatures were obtained in the *Challenger* at 150 positions, observations having been made at each 100 fathoms to 1,500 fathoms in depth, and frequently at, say ten fathoms to 200 fathoms in depth, at each of these positions. An examination of these temperatures shows that between the parallels of 40 deg. N. and 40 deg. S. there is a much larger amount of warm water in the North than in the South Atlantic, and that in the equatorial regions the isotherm of 60 deg. is much nearer the surface than in the temperate zones, but that the isotherms below 60 deg. are at nearly as great a depth at the Equator as in any part of the South Atlantic, especially at the isotherm of 40 deg.,

and that between the parallel of 30 deg. and 40 deg. N. latitude, the isotherm of 60 deg. occupies a depth of 300 fathoms, over an area of 1,200,000 square miles, while the average depth of this isotherm between the parallels of 30 deg. and 40 deg. S. latitude is 160 fathoms; also that the isotherm of 40 deg. which is at an average depth of 800 fathoms across the North Atlantic, between the parallels of 30 deg. and 40 deg. N. latitude, occupies only half that depth in any part of the South Atlantic. This phenomenon may be explained in the following manner:—The power of the sun indirectly heating the water below the surface appears not to extend below 100 fathoms even in the tropics, and this power decreases as the higher latitudes are reached, until a position is attained where the temperature is that of the freezing-point of salt water. As salt water at its temperature of congelation is denser than at any higher temperature, its weight would cause it to sink, and it would in time, did no other cause intervene, occupy the whole of the space in the ocean not influenced by the sun's heat. But in considering the effect of the heat imparted to the surfaces we have also to consider the effect of evaporation and precipitation. In the equatorial regions evaporation is rapid, so that the surface film would become cleared through increased salinity were it not for the increased temperature and large precipitation, as well as to its being transported by the friction of the trade winds and earth's motion to the westward. This surface film, constantly moving westward in the equatorial regions, meets in the Atlantic with an obstructing point of the South American continent, which directs it to the northward, so that the greater part of the water directly heated by the sun's rays in the tropical regions is forced into the North Atlantic. As the salinity of this water is greater than that of the subjacent layers, and its increased temperature only renders it less denser, directly a portion of this temperature escapes in the colder regions of the temperate zone, the surface film sinks and imparts heat to the water beneath. Consequently, the isotherms will be found at greater depths where the heated surface films are constantly descending than when, owing to their being less denser than the subjacent layers, they remain on the surface.

Mr. J. Murray stated some results of his observations on board the *Challenger—On the Geological Distribution of Oceanic Deposits.* These deposits were stated to be of three classes—first, those which were found all round the continents and islands existing over the world, without any exception, but which varied according to the places where they were found; secondly, those found at from 200 to 300 miles from the land, consisting of shell and lime deposits, and covering most of the bed of the ocean; thirdly, those existing at other depths, and which were of silicious character. The observations showed that a curious relation existed between the nature of the deposits and the depth of the water. It was also pointed out that in the neighbourhood of volcanic islands, and in no other places, were found large deposits of manganese, coating the shells and other things brought up from the bottom.

Mr. Buchanan submitted a communication of observations of the *Challenger*, bearing upon *The Specific Gravity of the Surface Water of the Ocean.* He also explained the principles on which he constructed a new deep-sea thermometer with which his observations were made.

Professor Porter read a paper *On some Points of Interest in the Physical Conformation and Antiquities of the Jordan Valley.* The general geological structure of the valley was, he said, of lime, and of the same age as the basin of the Sea of Galilee, and its surface was flat. The breadth varied from three to ten miles, extending a little towards the east, and from the nature of its thick alluvial covering, it was of more recent formation than of the mountains, the valley having been at one time apparently a lake, of which the soil was the deposit. The river Jordan as it at present existed, could have had nothing to do with the formation of the valley itself. He recommended to the notice of men of science that geological remains on the site of Sodom and Gomorrah pointed to an explosion of bitumen much later than the ordinary geological formation, and probably within the historic period.

Signor G. E. Cerruti read a paper *On his Recent Explorations in N. W. New Guinea.* After several visits to the islands and part of the mainland on the north, he was in 1869 sent out by Count Menabrea for the purpose of making investigations preliminary to the formation in New Guinea of a penal settlement. He secured at the same time means for turning his expedition to profit geographically. He believed that a great part of the region from the Xulla Islands to New Guinea, and perhaps more to the north, had been subject to very important volcanic action in an epoch not very far distant, and one could see the work now going on—the western coast showing gradual subsidence. But whatever the origin of the islands, they were now covered with a vegetation which he had not found equalled in luxuriance in any part of the world. He urged in strong terms the colonisation of New Guinea.

This Section was brought to a premature close on Tuesday the 12th from want of an audience. The meetings were held in the Queen's Rooms, at a considerable distance from the University, which no doubt to a great extent accounts for the poor attendance.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

Dr. William Jack read a paper *On the Results of Five Years Compulsory Education.* After entering into considerable details as to the working of the system, he concluded that he had established the following points:—1. That the need of the country for compulsory education was a crying need in 1870. 2. That the success of the experiment which has now been tried in Scotland, and in nearly half of England, justifies the very modest advances that have been made by the Government in the bill of the present year. 3. That compulsion has been carried out in one great city with perfect efficiency, and with a very trifling amount of legal process. 4. That there is no agency short of compulsion which can bring Ireland on a level in popular education, with her sister countries. A very interesting discussion followed the reading of this paper.

Mr. J. Heywood, F.R.S., read a paper *On the Memorial of Eminent Scientific Gentlemen in favour of a Permanent Scientific Museum.* He advocated the placing on a permanent basis an institution similar to the Loan Scientific Institution now open at South Kensington.

The Rev. Dr. M'Cann then read a paper *On the Organisation of Original Research*, in which he advocated an exceedingly elaborate system for carrying out the object in view.

After some discussion in which Dr. Jack, Professor Hennessy, of Dublin, and others took part, Mr. Heywood submitted the following resolution—"That this Section approve of the maintenance of a scientific museum in London, containing scientific apparatus, appliances, and chemical products."

Sir George Campbell, in summing up the discussion, said he should support this motion, and he also agreed with Dr. M'Cann that there should be a national system of scientific education.

The motion was unanimously passed.

An important discussion took place in this Section *On the Civilisation of South-Eastern Africa*, caused by the reading of a paper on the subject by Mr. Stevenson.

SECTION G.—MECHANICAL SCIENCE.

This Section met under the presidency of Mr. Charles W. Merrifield, F.R.S., who in his address spoke of our shortcomings in those subjects of instruction which are the necessary preludes to mechanical science. He urged the importance of physical science as that which had given us command over the material powers of nature, and which alone could enable us to keep pace with other nations in industrial competition, and to maintain the health of crowded populations. With their populations, which had more to fear from war and famine than from want of elbow-room, political and historical knowledge in the governing class was more important than exact knowledge in the administrative class; but as the population thickened, the latter assumed more importance; and while he did not think political wisdom would ever lose its value, he thought it only a part of such wisdom to recognise that in such communities as ours the spread of natural science was of more immediate urgency than any other secondary study. One of the obstacles to the spread of science and to our national prosperity he took to be the undue preference given to literary over natural knowledge, and in particular the sacrifice of mathematics to classical study in the secondary schools. Apart from the general fault of giving too low a place to mathematical teaching, a great fault was our not paying sufficient attention and sufficiently early attention to mechanical and geometrical drawing. He concurred with a remark of Professor Fleeming Jenkin that descriptive geometry was not what was wanted. A much more important exercise of geometry, and one more immediately useful, was the geometrical representation of arith-

metic, such as was seen in diagrams of thrust, pressure, speed, and so forth. But this would take care of itself provided linear drawing were taught sufficiently early. Passing on to discuss certain points connected with the crowding of the population, he remarked that the real problem of civilization had been to render life tolerable in large aggregations, and that this problem was yet only partially solved. Among the difficulties of town life he reckoned—(1) the insufficient supply of fresh air; (2) the mere proximity of persons facilitating the spread of contagious or infectious disease; (3) the getting rid of excreta or waste products; (4) a wholesome water supply to be provided and kept pure.

Mr. Baldwin Latham read a paper *On Hydro-Geological Surveys*, in their bearing on health. He dwelt on the importance of ascertaining the sub-water course, and making certain that the well was on a higher level, so that it could not be contaminated by cesspools or other pollutions. These surveys showed the absolute necessity of sewers being made water-tight.

Mr. W. J. Millar read a paper *On the Strength and Fracture of Cast-Iron*. The author described the results obtained in testing cast-iron bars 36 inches span, 2 inches deep, and 1 inch broad. The bars usually broke with straight fractures, but occasionally curved fractures were observed. The average breaking strength of 29 bars showing straight fractures was 3584 lbs., the average strength of 25 bars showing curved fractures was 3551 lbs. Some results of "set" and deflection were given, showing that for successive applications of the same load, 2800 lbs., there was a decrease of set. The principal object aimed at by the author of the paper was to show the relation existing between form and position of fracture, straight fractures taking place at or close to centre of span, and curved fractures occurring at points more or less removed from centre of span.

Sir William Thomson read a paper *On Naval Signalling*, in which he advocated the use on board ship of the fog signalling system instead of the flag system now in use. His method is simply this—to signal according to the Morse telegraphic code by means of two sounds of slightly different pitch. For the long signals he would take a grave note, and for the short signal a less grave note, or what he might call an acute and a grave note for the dot and the dash. Sir William Thomson then gave several signals to show the efficacy of the plan he proposed, and he maintained that the shortness of the time required to make flag signals was far less than could be attained by the phonetic method. Long before the signal flags could be hoisted, the order would be given and read by every ship, and repeated by the different ships in order, back to the admiral. Two sounds of different pitch made in rapid succession was all that was necessary, and to accomplish this all that was required was two steam whistles, each with a different note.

Many other papers of great value were read both in Sections F and G, but as they were mainly technical, or very special, our space prevents us referring to them in detail.

THE CHALLENGER EXPEDITION[1]

THE task which I have undertaken this evening—to give a general sketch, however slight, of the work and results of the *Challenger* expedition in the space of a single lecture—is by no means an easy one, for two reasons. The various lines of inquiry bear on so many different subjects, and these dovetail into one another in such a complicated manner, that it would take many hours to explain them even in the most superficial way. The other reason is that the observations which were made during the *Challenger* expedition have only as yet been very imperfectly examined, and only half digested, owing to want of time, and the great collections in natural history which were brought home in the ship have been only glanced at, and it is therefore scarcely safe for me to use either the observations or the collections as the bases of generalisation. I must therefore this evening, in this address, only be regarded as giving a most elementary idea of the objects of the expedition and its results, and what I say must be regarded as preliminary, and subject to further reconsideration. Still, some new and remarkable facts and phenomena which have hitherto been unknown, or only vaguely guessed at, are sufficiently definite, and I will devote the short time at my disposal to the consideration of one or two of these. The superficial area of this world of ours is about 197,000,000 of square miles, and of these about 140,000,000 are covered by the blue sea at an average depth of 2,500 fathoms—about 15,000 feet. This vast region under the sea has not until comparatively recently excited much curiosity. It seemed to be practically inaccessible, and certain hasty and incorrect assumptions in regard to some of its conditions had reduced it to a barren uniformity and divested it of any interest. The laying of deep-sea cables for the purposes of ocean telegraphy, by bringing to light certain phenomena which threw a doubt upon previous conclusions, stimulated inquiry, and gave rise to new speculation; and the systematic scientific exploration of the depths of the sea by several special exploring expeditions put our knowledge upon a totally different footing. We now know that the sea covers a vast region which is to a certain degree comparable with the land—a region which has its hills, valleys, and great undulating plains; that it has its various soils—widely different materials laid down and accumulated in different places; that it has its climates, whatever the very exceptional conditions of those climates may be; and that it has its special races of inhabitants which depend, like the inhabitants of the rest of the world, upon the conditions of climate and on the nature of the soil for their distribution.

The *Challenger* expedition was despatched on a very special errand—to investigate the physical and biological conditions of the great ocean basins. And, under this general heading, certain more minute instructions indicated the particular questions, physical and biological, which were specially to engage our attention. We were instructed throughout our long course, which extended round the world and traversed the Atlantic and Pacific Oceans and the Southern Sea so far south as it was possible to go without running the risk of being entangled for a winter in the ice—a contingency for which we were not prepared—to select certain stations at convenient distances, and at each of these to determine certain points. We were to determine, in the first place, the exact position of the station; then, with the best appliances at our disposal, we were to determine the precise depth; we were to bring up by means of the sounding apparatus a certain amount of the material of the bottom for microscopical examination and for chemical analysis; we were to bring up a specimen of the water from the bottom for analysis and physical examination; we were to determine the bottom temperature with accuracy; and we were to determine the temperature of the sea at different levels from the surface to the bottom; we were to get specimens, if possible, of the sea water from various depths. Lastly, we were to endeavour, by the use of the trawl or dredge, or any other instrument which might be suitable, at each station to procure a fair sample of the creatures which inhabit the bottom, and in this way to get, if possible, a general idea of the fauna inhabiting the depths of the sea. The instructions of those in charge of the scientific departments in the *Challenger*, both naval and civilian, did not, however, by any means end here. The officers had been selected in order that they might study by the light of their own previous experience the bearings of those various data upon one another, and this was a very serious addition to the work of the expedition. It was found necessary, in order that this might be carried out to its fullest extent, that the instructions given by the Admiralty should be comparatively flexible, and that the details of the working of the ship should be left to a certain extent to the captain of the ship and to the director of the scientific staff, so as to enable them to deviate from any definite line or course when it became desirable for any purpose that they should do so. I have only to add that the equipment of the vessel was such as to leave very little to be wished for, and that the liberal arrangements of the Admiralty, which were admirably carried out by the Hydrographic Department, worked in the most satisfactory way. The *Challenger* left Sheerness on December 17, 1872. She crossed the Atlantic four times during the year 1873, and along a course of nearly 20,000 miles she established 150 observing stations, at each of which, with few exceptions, all the required observations were made. In 1874 she went southwards from the Cape of Good Hope, spending nearly a month among the southern ice, and dipping within the Antarctic Circle, as far as she could with safety, considering the lateness of the season and her unprotected condition. She then traversed the seas of Australia and New Zealand, and made some most interesting observations among the islands of the Malay Archipelago. She arrived at Hong Kong on November 10, having run a course in the year 1874 of upwards of 17,000 miles, along which sixty-six observing stations had been established. In 1875 she traversed the Pacific, with a course of about 20,000 miles and 100 stations; and in the early part of the present year she crossed the Atlantic for the fifth time, filling up here and there blanks in her former

[1] Report of Address given at the Glasgow Meeting of the British Association, September 11, by Sir C. Wyville Thomson. Revised by the Author.

observations brought out by increased experience, and reached England on May 24, 1876.

The cruise on the whole has been singularly fortunate, and it has only been in very unusual circumstances that we have been prevented by the weather from doing our work. The health of the party has been exceptionally good, and the loss by death small. Two misfortunes only befell us in any way sufficiently grave to affect the success ot the expedition—one was the death of one of the most zealous and most promising of our civilian staff, Dr. von Willemöes-Suhm, which for long through a gloom over our little party; and the other was the recall of Capt. Nares to take command of the Arctic Expedition. Capt. Nares had acquired, to a remarkable degree, the esteem and confidence of all on board, and although we could not but feel that no other selection of a leader for the Arctic Expedition could have been made in any way so satisfactory, still the fact remained that by the loss of his experience we were greatly crippled. We all trust that he and his bold companions may now be in safety and nearing the goal of their hazardous enterprise; and I am sure that, with the exception of his wife and children, none so earnestly pray for his welfare as his old comrades of the *Challenger*.

Before endeavouring to sketch one or two of the general results at which we have arrived, I wish to give a few words of explanation. I shall have to bring before you various matters which to you may appear novel, but many of these are not entirely original—many have been shrewdly hinted or guessed at from time to time, and many isolated observations have furnished clues which have been eagerly seized by students and made the bases of speculations more or less touching the truth. It is only the unexampled opportunity which we have had at our command which now enables us to place them before you in a connected form, and with a completeness which in some directions at all events precludes the possibility of grave error. It would be impossible for me on this occasion to acknowledge individually the debts we owe to our predecessors, but I must do so in one or two instances. The American Coast Surveyors commenced this work about the same time that we did, and their results are of the greatest possible value. I have only lately become acquainted with a most thoughtful and suggestive paper by Prof. Williamson, which was published so far back as 1847, in the *Transactions* of the Manchester Philosophical Society, in which the origin of organic deposits—one of the most important points which we have to consider—was worked out with great care and skill. In 1869, 1870, and 1871 the observations made in the *Lightning*, *Porcupine*, and *Sheerwater* completely revolutionised our ideas of many of the questions involved. I shall not, however, consider it necessary to quote continually the speculations of my colleague, Dr. Carpenter, on the physics of the ocean, to which, however widely I may differ from his conclusions, I attach a high value; nor the investigations of Mr. Gwyn Jeffreys on the distribution of marine animal forms; for these two gentlemen must be regarded as members of the firm. Among the many points of interest which engaged our attention there were three more especially prominent, and, if possible, I will confine myself to these three, so as to bring my work within a certain limit. The first of these the contour of the bottom and the nature of the deposits now being formed upon it; the second is the more difficult question of the distribution of deep-sea climate; and the third, which is perhaps the most interesting and curious, is the nature and distribution of the peculiar races of animals which are now found at the bottom of the sea. I shall take up these three points in succession, and endeavour very briefly to give an idea of the condition of knowledge with regard to them when the *Challenger* started, and the light which her observations have been enabled to throw upon them.

I need scarcely go into great detail with regard to the contour of the bottom, for the question is mainly a hydrographic one, and would involve use of numbers which would be scarcely suitable for a public lecture. As I have said already, the average depth of the ocean is somewhere about 2,000, or probably 2,500 fathoms. A very large portion of the ocean has a depth somewhat less than this, and a depth of 2,000 fathoms appears to be common. Where it is 2,500 or 3,000, we would appear to be going into submarine valleys, with the exception of the North Pacific, where there is an enormous extension of water of great depth, in many cases going beyond 3,000 fathoms. In the Atlantic, a great part of the northern portion has a depth of about 2,000 fathoms, with a middle ridge which passes down from Greenland, and includes the various groups of islands and single islands to Tristan d'Acunha, and probably beyond it. In the South Atlantic, on each side of this ridge, which is there called the "Dolphin Rise," in compliment to the American ship which first surveyed it, there is a trough which runs to a considerable depth, usually down to 3,000 fathoms, and these form marked depressions roughly parallel with the axes of the South American and African continents. I will frequently allude to the Atlantic, as I have no time to enter into detail with regard to the rest of the seas, and we had the best opportunity of working it. Now, the bottom of the sea is covered with certain deposits. The whole bottom of the sea, so far as we are aware, is gradually receiving certain accumulations, and these accumulations are giving rise to formations which we look upon as the rocks of the future. We know by our knowledge of the science of geology that the whole dry land, as we have it at present, is composed—with the exception of certain volcanic rocks, which may be, in many cases, metamorphosed sedimentary rocks—of stratified beds laid down at the bottom of the sea. We know that the material of these beds is to a certain extent derived from the gradual disintegration of the land, and we look upon the sea as the great restorer of the solid material which is to form future islands and continents, as the bottom of the sea becomes raised up at some future time above the level of the ocean. Now, the whole of the sea-bottom is receiving these deposits, and it was one of our great objects in the cruise of the *Challenger* to determine what these deposits are, under what laws they are being laid down, and what the relation of these modern deposits may be to the ancient deposits, which form the solid crust of the earth. We were well aware that there was a perpetual disintegration of the land going on by rivers and by the action of the sea round its coasts, and that the material worn off the land was being carried away by the ocean and laid down at some distance from the land, and that the material was being selected and arranged according to some definite laws. Accordingly, when we came to test this, we were not surprised to find that the *débris* of the land extended for some hundreds of miles from the land out to sea. We found clays being formed, and various deposits, differing according to the material from which they were derived, and mixed up with the *débris* of animals living in the places where these deposits were being laid down. Within a certain distance of the land we found the deposits formed to a great extent of this peculiar shore material.

Many years ago it was determined by observation, even previous to the soundings for the first Atlantic cable, that over a great part of the North Atlantic a very remarkable deposit was being laid down—a deposit now known as *Globigerina* ooze. This deposit consists of the shells of minute *Foraminifera*, principally belonging to one genus—the genus *Globigerina*. This, as we found it in these deposits, was a small chambered shell extremely minute, about a millimetre in diameter, and these shells were found in enormous quantity. When dry, the ooze was something like fine sago, with little round shells falling from one another, and showing that the deposit was formed almost entirely of such shells. Some other genera were mixed with them, but the great mass were *Globigerinæ*. When we took up by any means material a little below the surface of the sea-bottom we found the *Globigerina* shells were becoming broken and compacted together so as to form a close and nearly amorphous mud, in which there were very many complete *Globigerinæ* and many pieces of the same. The whole of this deposit was composed almost entirely of carbonate of lime, and the only rock which this could possibly form was a limestone. It therefore appeared that over a very large portion of the North Atlantic, and over many other parts of the world where these observations had been made, this limestone was being laid down. Further observations showed that the chalk was composed of very nearly the same material, and the analogy between these modern formations and the chalk became very apparent. During the voyage of the *Challenger* we had many opportunities of bringing up this modern chalk, and the question which was always before our minds was one which had been mooted before we started—Where did these creatures live—did they live upon the bottom of the sea? or did they live on the surface, their shells falling to the bottom after death? Until lately none of these animals, or very few, had been found alive upon the surface. It was our general impression that they lived on the bottom, where we found their dead shells. Mr. Murray, one of my companions in the *Challenger*, has paid particular attention to the structure of the material brought up from the bottom—its composition, and the sources from which it was derived. He worked the tow-net and the sounding apparatus together during the voyage, and came to a decided conclusion, one to which we are absolutely forced to

agree with him. The tow-net upon the surface, and particularly at a little below the surface—that is to say, to the depth of a few fathoms, or even to a hundred fathoms—takes enormous numbers of these *Foraminifera*, which make up the *Globigerina* ooze alive. The *Globigerinæ* themselves, in many seas, are most abundant, and they present characteristics totally different from the shells as we find them below; so that I think there cannot be the slightest doubt that these shells live on the surface, and a little below the surface, and that the whole material at the bottom composed of these shells is derived from the surface. When we find these shells at the bottom they are little globules all united together, and forming a little compound mass of globules. These are rough on the surface, and perforated with minute pores. The cavity of the shell contains a little reddish material, which, at first, we were inclined to suppose was the remains of the body of the animal. When the *Globigerina* was found on the surface, the shell was of the same form, but instead of being white and opaque, it was perfectly clear and transparent. A raised frill on the shell forms a hexagon round each minute pore and runs into six points, and from each point a long spine projects—in fact the shell bristles with long spines running out in every direction, the axes of the spines on each chamber meeting in the centre of the chamber. The shell has a little animal in the interior of it, and that animal consists of a particle of gelatinous matter like the white of egg, and when alive this matter runs out of the holes on the surface of the shell to the end of each of the spines, where it absorbs minute particles of organic matter floating in the water. The *Globigerinæ* seem to be of the same specific gravity as the water, their weight being reduced by large oil-globules scattered in quantity through their substance; they exist in myriads on the surface, while they are perpetually dying and sinking to the bottom. Finding them so abundant in a living condition on the surface or a little below, and finding none living at the bottom, there seems to be little room for doubt that the *Globigerina* ooze is due simply to the accumulation of the dead shells of the inhabitants of the surface and of moderate depths. We should therefore at once come to the conclusion, if this be true, that the formation which arises from their accumulation ought to be as universal as they are themselves. Singularly enough, this is not the case, and this is one of the most curious points which we have determined. When we go to a depth of about 2,000 fathoms we find that the shells at the bottom are becoming, as it were, rotten or yellow, they have not the same white clear appearance which they had in shallower water, and if we go to a depth of 2,500 fathoms or so, we find no shells whatever, but that the bottom consists of a homogeneous red mud, which, instead of consisting of carbonate of lime, is formed of the materials of ordinary clay. Now, as a very large portion of the sea is below 2,000 fathoms in depth, probably by far the greatest portion is being now covered by red clay, and not by calcareous formations. The question at once arises, How is it possible that these calcareous formations are stopped at a certain point and replaced by red clay? There is no doubt that the calcareous formation is arrested by the carbonate of lime being in some way or other removed from the shells of these creatures. When we come to a certain depth the carbonate of lime is dissolved, and we have a fine red clay instead. The cause of the removal of the carbonate of lime is as yet rather obscure. We were at first inclined to believe that it is removed by excess of carbonic acid in the water. If the water contained an excess of this acid it would dissolve these shells, and it is just possible that the excess of carbonic acid in these depths may remove the carbonate of lime. We also find a large quantity of sulphate of lime dissolved in the sea, and it is just conceivable that a considerable amount of sulphurous acid may be percolating through the crust of the earth at various places, and that it may be converted into sulphuric acid, which would dissolve the carbonate of lime. But whatever be the reason there cannot be the slightest doubt that on reaching 2,000 fathoms depth the lime is gradually removed, and we have the red clay. There is another important and curious question arising—namely, where does the red clay come from? The red clay consists of the silicate of alumina and iron. This compound does not exist in any quantity in the shells in that particular form, and there is no doubt that some complicated changes taking place in the sea at this moment are producing this silicate of alumina and peroxide of iron. There is one very remarkable thing which has been observed by Mr. Murray and Mr. Buchanan, who have been watching this matter with great care, and that is that all over the sea there is a large quantity of pumice. Volcanoes—either sub-ærial or sub-marine—either exposed to the air or under the water—are perpetually throwing out material from the crust of the earth, and the pumice, which is the froth of the lava—lava divided minutely and containing bubbles either of steam or air—is very frequently so light as to float freely in water; and almost wherever we were, in all parts of the world, we found that particles of this pumice had been caught by the sea, and so moved about in currents slowly over the surface of the ocean. In almost all parts of the sea, the trawl or the dredge brought up bits of pumice which had been waterlogged and had fallen down to the bottom, probably after swimming or floating about for a very great length of time. This pumice was constantly in various stages of decomposition, and its decomposition like that of all felspathic minerals must result in the production of a clay. It is very certain now that these calcareous formations which are being produced by the animals floating upon the surface of the sea and falling to the bottom, and there accumulating, are by no means universal, but that besides these there are huge formations of clays which are capable of giving rise to important formations of schists being produced at the bottom of the sea at the present day. Over the whole bottom of the Pacific, or a very large part of it, we find red clay, and particularly in the North Pacific, where there is a great depth of water. The red clay has all through it nodules, which vary from the size of sago or a canary-seed to the size of a child's head or an orange, composed of nearly pure peroxide of manganese. These are found in enormous quantity. The trawl sent down to the bottom in those regions brings up masses of concretions, much resembling lumps of the mineral known as *wad*, almost all of which contain as a kernel in the interior a fish's tooth, or a little bit of sponge, or some fossil of some kind, which has formed the nucleus round which the manganese has accumulated. This is altogether a most peculiar and novel observation. In the Atlantic and all over the bottom of the sea we find manganese in minute bits, but in the North Pacific particularly these pieces are in very great quantity and attain a large size. This is a phenomenon which we are as yet unable to explain, and I do not know that there is any analogous instance in any of the older formations.

Along with the *Foraminifera* we have living in the sea a great number of extremely beautiful little organisms, which are known under the name of *Radiolarians*. Instead of these having calcareous shells, they have silicious shells—sometimes external, sometimes internal, but very generally presenting extremely beautiful forms. The *Foraminifera* appear to live mainly upon the surface, or a little below it. In regard to the *Radiolarians*, it seems to be somewhat different, for when the tow-net is dragged along the sea even at the depth of 1,000 fathoms, we find that the number of *Radiolarians* increases, and that the size of the specimens of the species which are found on the surface is rather greater; and many forms occur at those great depths which are not found on the surface at all. Therefore we are inclined to believe that the *Radiolarians* live all through the sea, and down to its greatest depths, which may be something like five miles. Now, you can easily understand that these things, living in this way, add considerably to the formations which are taking place at the bottom. We even found a formation which has been called by Mr. Murray *Radiolarian* ooze, on account of its consisting almost entirely of the remains of *Radiolaria*. The mode of formation of this ooze is peculiar; it seems that the *Foraminifera*, living only near the surface, have their shells entirely dissolved before they reach the bottom; the red clay is laid down as usual, whatever may be its source; but the shells of the *Radiolarians*, living throughout the whole of the vast depth, are so numerous as entirely to overcome and mask all the other constituents of the bottom. This formation, however, only occurs at very extreme depths, and it is therefore apparently in patches at the bottom of the sea. In the Southern Sea, where the depth is not so great as the Pacific or Atlantic, we find that the surface, instead of being covered with *Radiolarians* is covered with a set of minute plants which have silicious coverings. Those plants are living on the surface in enormous quantity, and consequently dying on the surface. And when you drag the dredge or trawl over the bottom it comes up with a white matter, which looks at first extremely like chalk, though it is formed entirely of silica. There are many other points of great interest connected with these recent deposits, but my time will not allow me to refer to them. I will, therefore, now pass on to the second question of special prominence—the climates of the sea.

The temperature at the depth to which I alluded—namely, 2,500 fathoms—is very low. Over the whole bottom of the Pacific and the Atlantic, and those portions of the Southern Sea which

we have examined, the temperature is usually a little above the freezing-point. Down in the valleys it sinks to perhaps pretty near the freezing-point in some places, and in some very few places it sinks a little below it, but it is only in one or two places in the Atlantic and Pacific we find such extremely cold water. Over the elevations the temperature is somewhat higher; but in the Atlantic and the Pacific, as a rule, the rise of temperature on the ordinary elevations of the bottom of the sea is not above two or three degrees. The temperature of the bottom of the sea is, therefore, as a rule, a little above the freezing-point. When we examine the temperature of such an ocean as the Atlantic, from the surface down to the bottom, we find that it gradually falls. On the surface its height is according to the season of the year, according to the latitude, and according to the heat of the sun at the locality observed, or at that from which the surface-water is immediately derived. The temperature often rapidly falls for a certain distance and then it more gradually falls to a depth of about 500 fathoms, when it has a temperature of something like 45°. That is a very general temperature for a depth of about 500 fathoms. From that point downwards the temperature very slowly and gradually falls, and it falls till it reaches a temperature of 37° or 34°, or, as I have said before, sometimes below the freezing-point. Now, the consequence of this is that we have a very uniform as well as a very low temperature at the bottom of the sea, and we shall see shortly the result of this on the distribution of animal life. It is a uniform temperature, but it is a temperature which varies within certain limits. The question comes—Whence does the ocean derive this peculiar temperature? and this is a question of very great difficulty, and one which I have not to-night sufficient time to go into in detail, but I shall merely give you a general idea of the impression which is on our minds after the observations of the *Challenger* with regard to the sources of temperature in the Atlantic. The surface, as I have said, is affected by the heat of the sun, and by the conditions of the latitude down to perhaps about 500 fathoms. It is also very greatly affected by currents which are moving through the sea, and which are mixing water of different temperatures, and bringing water of different temperatures from different places. There is one set of currents which is particularly marked and which tends to spread warmth over the surface of the northern and southern seas, and modify the ocean temperatures. These are the great currents which are running from east to west driven by the trade winds blowing along the equatorial region and driving before them the equatorial water. They are met by the great continents—one is met by Cape San Roque in South America, in the Atlantic, and against Cape San Roque it divides: one portion going northward and another southward. In the Pacific the current is met by the coast of Asia, and in the same way one portion runs northwards and the other southwards. Thus warm water, being driven to the north and south, becomes mixed with colder water, and the temperature is modified and ameliorated by it. It is likewise affected by other currents which are produced by various reflections against coasts and other obstacles. In this way we have water moving about on the surface and conveying temperature from one place to another, and rendering the temperature of these upper 500 fathoms extremely irregular. In the Atlantic we find that from this point—about 500 fathoms—to the bottom the temperature steadily decreases until it comes down to near the freezing-point, no matter the surface-temperature or the latitude. We have come to the conclusion that this great mass of water is moving from the Southern Sea, and there seems to me to be very little doubt—although this matter will require to be gone into carefully—that the reason why this water is moving from the Southern Sea in a body in this way is that there is a greater amount of evaporation in the North Atlantic and over the Northern Hemisphere generally, than there is of precipitation, whereas it seems almost obvious that in the Southern Hemisphere, in the huge band of low barometric pressure round the South Pole, the precipitation is in excess of the evaporation. This is an extremely simple way of accounting for this mass of cold water which it has been hitherto found impossible to account for on any reasonable theory.

There is a minor phenomenon connected with this grand system of circulation which passes partly through the atmosphere and partly through the ocean, which is extremely pretty, and of this I will endeavour to give you a single illustration; and in order to understand it fully I will ask you to imagine for a moment a terrestrial globe and the relations in volume and position which the oceans and the continents bear to one another. You remember the vast accumulation of water round the South Pole, and in the South Pacific; and the "land hemisphere" almost in the centre of which we now stand, with the two great gulfs, the Pacific and the Atlantic running up into it, almost cut off by land and shallow water to the northern end, but opening widely to the Southern Sea. Now imagine the depth along a line joining Cape Horn with the Cape of Good Hope to be 3,000 fathoms, the bottom temperature being 30°, and the temperature at 2,500 fathoms 32°, and suppose a continuous barrier to extend between the two capes to the north of this line, rising 500 fathoms from the bottom; it is clear that if the movement of the mass of cold bottom water be constantly from the south to the north, no water colder than 32° can ever enter the Atlantic, and however deep portions of that ocean may be, water under that temperature can never be found in it to the north of the 2,500 fathom barrier.

Although this is an imaginary case, at least one which is scarcely in nature so simple as I have represented it, we find the same law acting perpetually. In various parts of the world there are little isolated seas, and circumscribed basins of the great ocean, surrounded by such barriers, and we can tell at once the height of the lowest part of the barrier by the temperature of the bottom-water of the basin, for we know that it must correspond with the depth at which the like temperature occurs in the outer ocean from which the basin derives its supply.

I have now only a few minutes left to refer to the last of the three questions selected for consideration, the distribution and nature of the deep-sea fauna. The deep-sea is by no means barren, but on the contrary a fauna very remarkably constituted and comparatively rich, is universally distributed even to the greatest depths. It was our impression that when we examined this fauna we should find it very analogous to that of the ancient chalk, for we believed, and we believe still, that the deposition of chalk has been going on continuously in various parts of the ocean, from the chalk period to the present time. In this expectation we were to a certain extent disappointed, for the species found in the modern beds are certainly in very few instances identical with those of the chalk or even with those of the older tertiaries. But although the species, as we usually regard species, are not identical, the general character of the assemblage of animals is much more nearly allied to the cretaceous than to any recent fauna. You have in the Clyde district some extremely interesting little localities—one for instance in Loch Fyne near Inverary, and another at Oban—where animals are found in shallow water which are usually only found in deep water, and other animals which are chiefly confined to the Arctic Seas. Prof. Edward Forbes called these animals *Boreal outliers*, and believed that the little basins in which they occur in this country—which are always cherished dredging spots for naturalists—are spots where, owing to the configuration at the bottom and to other causes, patches of the old fauna have been entangled and retained at the close of the glacial period.

Here and there on the surface of the earth we seem to have, in like manner, what we may call *Abyssal outliers*, spots where, during some process of elevation, the abyssal fauna has been caught and kept at an accessible depth. Such spots occur off the coast of Japan, near Yokohama, at various places among the Philippine Islands, off the coast of Portugal, and off the north coast of Scotland, and from each of these strange and beautiful things were brought to us from time to time, which seemed to give us a glimpse of the edge of some unfamiliar world. Among these were the lovely and wonderful *Euplectellas*, and glass-rope *Hyalonemas*, and bird-nest-like *Holtenias*, and many others of the hexradiate order of sponges, the representatives, and no doubt the descendants, of the *Ventriculites* of the old chalk; and the graceful sea-lilies belonging to the *Pentacrinidæ*, and the *Apiocrinidæ*, whose aspect carries us back at once to the clays of the Lias and the terraced limestones of the Jura.

The fauna of the deep sea is wonderfully uniform throughout, no one who has once seen it can fail to recognise this general uniformity, whether he examines it in the middle of the Pacific, in either trough of the Atlantic, or in the Southern Sea; and yet, although in different localities the species are evidently representatives, to a critical eye they are certainly not identical, and I believe that one of the most important lines of inquiry which have been opened up to us by these investigations is the range and amount of variation, or possibly the passage of one apparent species into another over this vast area, remoteness in space being, when we consider the conditions of migration with the accompanying change in surrounding circumstances, equivalent to lapse of time.

NOTES

THE Committee for the National Monument to Alexander von Humboldt publishes a report on the proposal to erect in front of Berlin University buildings statues to the brothers Wilhelm and Alexander von Humboldt. On the occasion of the 100th anniversary of the birth of the latter in the year 1869, a number of Berlin notabilities met for the purpose of organising a public memorial to the great scientific explorer at the expense of the German nation. A committee was chosen, whose labours were crowned with such success that a sum of nearly 100,000 marks was soon obtained. At the request of the committee to allow the statue to be erected in the University grounds, the Senate stated that they could only give their consent if at the same time a similar statue were erected to Wilhelm von Humboldt, the statesman who, as councillor to King Frederick William III., had an essential hand in the erection of the University. It was then resolved to erect the statues one on each side of the gate which separates the front garden of the University from the Opernplatz. On each side of the middle gate a niche will be made, and in these will the statues of the illustrious brothers be placed. As there was some difficulty as to the means for erecting the statue of W. von Humboldt, the Emperor was appealed to, and he has promised to endeavour to get it erected at the cost of the national purse. Thus then Berlin will soon possess two new statues in her Unter den Linden, and the German people will have paid a debt of gratitude long due to two of her noblest sons.

THE well-known physicist, Wilhelm Edward Weber, the last of what was known as the "Gottinger Sieben," celebrated on August 26, in Gottingen, his Doctor's Jubilee. Weber was born October 24, 1804, at Wittenberg, a brother of the physiologist and anatomist, Ernst H. Weber, with whom, in 1825, he laid, in the wave-theory, the basis of the new Optics and Acoustics. In 1831 he became Professor at Göttingen, and in 1837 resigned his chair; with him also protested against the abrogation of the Constitution Professors Albrecht, Dahlmann, Ewald, Gervinus, Jakob and Wilhelm Grimm, who, of course, also with him resigned their chairs, and with him went into exile. In the year 1849 Weber was restored to his chair, and has just celebrated his Doctor's Jubilee in full vigour of mind, and active as ever in scientific and literary work.

MR. J. COCKBURN, of Darn Hall, Eddleston, N.B., on the night of the 23rd, when taking a photograph of some of the stars, saw the brightest meteor that he has seen for two years. The time was 9.51 P.M.; it lasted about 1½ seconds, and left a train which was visible fully half a second after the disappearance of the meteor. The colour was a darkish green, and the train was orange. Its course was from above α Lyræ across the Galaxy towards Aquila. It disappeared before it had quite crossed the Milky Way. Dr. J. E. Taylor, of Ipswich, writes that on the night of the 24th a meteor fell there about 6.30, directly over the planet Saturn. The path described by the meteor was about one-sixth of the sky. Dr. Taylor never saw one so brilliant. The meteor seemed to burst before reaching the horizon, as if it had exploded. For nearly ten minutes the line of white cloud the meteor left behind it was visible, until at length it broke up into patches and drifted away. This same meteor was seen over a wide extent of country—at Broadstairs, West Deeping, in Lincolnshire, Ipswich, Walton-on-the-Naze, Somersetshire, between Dunkirk and Calais, and at Paris. *Galignani* says:—"A meteor of extraordinary brilliancy was seen in Paris during the twilight yesterday evening at 6.40. In the northern heavens, at an angle of 30° above the horizon, a fiery globe, about the size of a cricket ball, seemed to emerge from the clear sky descending slowly towards the earth, emitting showers of sparks and a scintillating train in its flight. It fell almost perpendicularly, and grew elongated in falling. It had hardly flashed into sight when it disappeared behind the houses, where it must have burst, for the whole northern sky was illuminated with two successive blazes of fire like lightning, by which the surrounding clouds were tinged as if with gold. The effect was extremely beautiful."

THE obstruction at the entrance to New York Harbour known as Hell Gate was successfully removed by an explosion of dynamite on Sunday afternoon without any of the disasters that many people anticipated. The mass to be removed was about 70,000 cubic yards. The number of borings was 3,500; the number of galvanic batteries 200, placed in an explosion-proof chamber at a distance of 200 feet from Hell Gate. The diameter of the borings was uniformly 3 inches, and the depth varied according to circumstances, from 3 to 11 feet. Fifty thousand pounds of dynamite were used. The shock was not perceptible, not even glass being broken. A vast volume of water and smoke was driven about fifty feet into the air. All the charges were exploded, and the rock is stated to have been thoroughly removed. The explosion was heard at a distance of ten miles, and a tremor like a slight earthquake was heard in New York City and the localities contiguous to Hell Gate. The work has been in progress for seven years.

THE *Golos* of Sept. 17 gives some late information received from Omsk, as to the Thibetan Expedition of M. Prejevalsky, and as to his latest arrangements relative to the route to be followed. From Omsk, which he left July 9 with MM. Povalo-Shveikofsky and Ecklon, he was to proceed through Semipalatinsk and Sergiopol to Kooldsha; thence, crossing the Tian Shan, he would go to the Lob-nor, where he is to stay during the autumn, until December. For the winter-months the expedition will return to Kooldsha. Starting thence in the spring, they propose to go through Karatar to Hlassa in Thibet. To the exploration of different parts of that country they propose to devote two years, after which they will descend the valley of the Brahmapootra. The expedition is well provided with means, having at its disposal 25,000 roubles. Their baggage, when it arrived at Omsk, weighed not less than 2,500 kilogrammes. As on his last journey, M. Prejevalsky has provided himself with a good supply of the means for hunting and self-defence, carrying 10,000 cartridges for rifles, 65 kilogrammes of gunpowder, and 250 kilogrammes of shot. Plenty of small steel instruments (knives, scissors, razors), looking-glasses, some silver tea-sets, &c., for commerce and presents, are said to be well chosen by M. Prejevalsky to gratify the taste of the Mongols.

THE splendid orang-utang in the Berlin Aquarium died last week of consumption. Its friend and playfellow, the chimpanzee, died the next day of consumption and grief. The young gorilla, the one living specimen ever brought to Europe, which we referred to some months ago, is still alive, but ailing. Hamburg not long ago offered 100,000 marks for the gorilla; it is feared that he will soon be sold for less.

AN organ for High Schools under the title *Alma Mater*, will be published in Vienna on October 1. It will appear weekly, will be exclusively devoted to the interests of the High Schools, and will advocate reforms in all academical matters. Many eminent professors in Germany and Austria have promised to become contributors.

THE City authorities of Munich have consented that the meeting for 1877 of the German Naturalists will be held in that town, and have also declared their intention of meeting all the costs of reception. An Ultramontane majority in the town-council of Aix-la-Chapelle, declared that the naturalists should not meet in that town.

THE fifth meeting of Russian Naturalists, which takes place this year at Warsaw, was opened on the 12th inst. It was well attended, the number of members having been on the opening day nearly 250, which number increased daily afterwards.

DR. THOMAS LAYCOCK, Professor of the Practice of Physic and Clinical Medicine in the University of Edinburgh, died at Edinburgh, on Thursday last.

THE number of visitors to the Loan Collection of Scientific apparatus during the week ending September 23 was as follows:—Monday, 3,082; Tuesday, 2,622; Wednesday, 375; Thursday, 345; Friday, 296; Saturday, 3,991. Total, 10,711.

THE Congress on Silk-culture, at its Milan Session, declared that its next bi-annual meeting should take place at Paris on the occasion of the general exhibition.

THE Champ de Mars has been quite closed for the works of the 1878 exhibition. A number of deputies, senators, &c., have been appointed by a recent decree members of the Administrative Commission. All the expenses of building, &c., will be supported by the public exchequer. The great undertaking is exclusively in the hands of the public administration.

DR. PETERMANN has received a telegram, dated from Hammerfest, September 19, announcing the safe arrival at that port, from the Jenisei River, of Prof. Nordenskjold's trading expedition which, it will be remembered, started from Tromso as late as June 25, on its voyage through the Arctic Ocean of Siberia to the mouth of the Jenisei. The voyage out to the latter and back was performed in about five weeks only, during sixteen days of which the expedition stayed at the Jenisei. The expedition found the sea perfectly navigable and free from ice; thus the practicability of a trade route from Europe through the Arctic Ocean to Siberia seems to have again been demonstrated.

THE British Association grant for the investigation of the constitution of the double compounds of nickel and cobalt was given to Mr. John M. Thomson, not to Mr. W. N. Hartley, as stated in our last week's list.

THE French Franklin Society, established for the creation of popular libraries, received a silver-gilt medal from the Brussels Exhibition for services rendered to public instruction.

THE direction of primary instruction in Paris is preparing plans for the establishment in that city of a normal school of gymnastics.

M. TISSERAND, Inspector-General of Agriculture in France, has been appointed director of the Agronomical Institute. The lectures will be given at the Conservatoire des Arts et Métiers, and the authority of General Morin will be paramount over the new institution. A notice to the public has been published in the official paper reminding them that the course of lectures will be opened on November 15. Pupils are obliged to present a diploma of *Baccalaureat-ès-Sciences*, or to pass an examination to prove that they are conversant with the subjects of the said examination. Tuition fees are 300 francs a year, but free pupils are admitted at a reduced fee of 25 francs. Foreigners are admitted without any limitation.

THE University of Heidelberg as well as medical science and practice, has recently sustained a great loss in the death of Dr. Simon, for fifty-three years a professor of surgery therein and a skilful operator.

THE ordinary professor of mathematics in Vienna University, Dr. Ludwig Boltzmann, has been appointed professor of physics and director of the Physical Institute in the University of Graz.

DR. TÖPLER has been appointed Professor of Experimental Physics in the Polytechnic School of Dresden.

MR. WILLIAM MATHEWS, jun., M.A., F.G.S., of Birmingham, has, in consequence of ill health, resigned the office of local Secretary to the Ray and Palæontographical Societies, which he has held for upwards of twenty years, and Mr. W. R. Hughes, the Treasurer of the Borough, succeeds him.

SESSION 1876-7 of the Birmingham and Midland Institute will be opened on Oct. 5 by an address by Mr. Joshua Morley. Among the lectures to be given during the Session are the following:—Oct. 13, Recent Explorations in Africa, by Lieut. Cameron, D.C.L.; Oct. 16, Antarctic Discovery, and its Connection with the Transit of Venus, 1882, by Capt. Davis, R.N.; Oct. 23, The Early Forms of Animal Life, by Prof. W. C. Williamson, F.R.S.; Oct. 30, The Early Forms of Vegetable Life, by Prof. W. C. Williamson, F.R.S.; Nov. 20, Spectrum Analysis applied to the Heavenly Bodies, by Wm. Huggins, F.R.S.; Dec. 11, The Ancient Inhabitants of the Caves of Derbyshire, by Prof. Boyd Dawkins, F.R.S.; Jan. 22 and 29, 1877, Rots and Ferments, our Unseen Enemies, by E. Ray Lankester, F.R.S.; March 12, The General Results of the *Challenger* Expedition, by Prof. Sir C. Wyville Thomson, F.R.S.; March 19 and 26, Radiation and Radiometers, by Prof. W. F. Barrett, F.R.S.E.

EARTHQUAKES were felt on the night of September 12-13, at Salonica, and in South Italy, at Reggio. Two motions were observed in the last city, the first one being the most notable, both having taken place on the 13th, between 12 and 1 o'clock, local time. Another earthquake was felt at Salonica, on the 14th, at 5 o'clock in the morning. The Reggio commotions were propagated to Messina and vicinity. They produced quite a sensation, although not destructive.

IN the *Bulletin Mensuel* of the Observatory at Montsouris for July is given an interesting comparison between the amount of atmospheric ozone observed by Schonbein's test-papers and that ascertained by the more exact method employed for some time at the Observatory, with the result that, setting aside all anomalies due to excessive moisture and excessive drought, and to the velocity of the wind, there is a pretty fair agreement between the amounts obtained by the two methods. It must, however, be added that while this result is in a sense gratifying, the observation of this important element by the ordinary method of test-papers is far from being satisfactory.

As the U.S. Congress has made the necessary appropriations to meet the expense of various Government geological and geographical surveys of the Territories, the parties have taken the field, and hope to accomplish a good deal, although the delay on the part of Congress in supplying the means will lessen the period of active work materially. Dr. Hayden's expedition will be divided into four parties. The first will be in charge of Mr. A. D. Wilson, with Dr. Endlich as geologist and Mr. Atkinson as topographer, and will complete the exploration of the small portion of Colorado lying near the Utah line, and then move northward on the west side of the Rocky Mountains. Mr. Henry Gannett will have charge of the second division, with Dr. Peale as geologist, and James Stevenson as executive officer. This division will revisit the region in which a portion of Prof. Hayden's party had an encounter with the Indians and was driven off, last year, with the loss of their implements. Mr. G. R. Bechler will be in charge of the third division, with the necessary assistants. He will pass westward through the Middle Park, working along the north-western part of Colorado. The fourth division will be in charge of Dr. Elliott Coues, with an assistant, and will be especially devoted to zoological work, visiting such portions of Dr. Hayden's region of investigation as have not been examined in previous years. Dr. Hayden himself will visit all the parties in the course of the summer and autumn, and co-ordinate their work.

SOME curious experiments on the expansion of liquids to lamellac, have recently been described by M. Cintolesi in the *Rendiconti Reale Institute Lombardo.* He considers that the phenomenon is always accompanied with a development of gaseous masses; further, that the spreading out of liquids on each other is caused by the vapours of the substances, whose molecules moving in every direction force the liquid molecules out from each other horizontally, and, where the resistance of the liquid is not strong enough, rupture the film.

IN his thermo-chemical researches on gold and its compounds, M. Julius Thomsen has observed that gold separated out form different solutions and by dissimilar reducing agents presents allotropic differences, three of which he has studied:—1. Reduced from chloride solution with sulphurous acid, gold forms a balled mass. 2. Reduced similarly from the bromide solution, it forms a very fine dark powder, which retains its powder form even after drying. 3. Reduced from the chloruret, bromuret, or ioduret, with sulphurous acid or hydrogen acid, it forms a very fine powder with metallic brilliancy and yellow colour. These modifications are also distinguished by unequal heat-energy in the several reactions.

FROM careful measurements during 1871 and 1872, it appeared that the quantity of water annually flowing past in the Elbe, at the boundary between Saxony and Bohemia, was about 6,179 million cubic metres. M. Breitenlohner, considering the quantity along with analyses he made of Elbe water in 1866, has calculated the amount of solid matter carried away by the Elbe out of Bohemia every year. His estimate is, for suspended matters carried off, 547·14 million kilogrammes, dissolved matters, 622·68 million kilogrammes (of which 977·7 million were fixed, and 191·12 million volatile), giving a total of 1169·82 million kilogrammes of solid substances carried off. The numbers are also interesting which indicate the proportions of substances important to agriculture that are thus removed from Bohemia. In the 6 milliards of cubic metres of Elbe water, there are partly, suspended, partly dissolved, 140·38 million kilogrammes lime, 28.13 million kilogrammes magnesia, 54·52 million kilogrammes potash, 39·6 million kilogrammes soda, 25·32 million kilogrammes chloride of sodium, 45·69 million kilogrammes sulphuric acid, and 1·5 million kilogrammes phosphoric acid. The Elbe has a basin of about 880 square miles in Bohemia.

AN essay on the Wines and Wine Industry of Australia, by Rev. Dr. J. I. Bleasdale (Melbourne: Baillière), contains a great deal of information on a subject of much industrial and economic interest.

PART I. of Vol. III. of the *Transactions* of the Connecticut Academy of Arts and Sciences is a thick one, and is profusely illustrated with well-executed plates. The papers are:—"Reports on the Dredgings in the Region of St. George's Banks in 1872," by Messrs. L. J. Smith and O. Harger; "Descriptions of New and Rare Species of Hydroids from the New England Coast," by Mr. S. F. Clark; "On the Chondrodite from the Tilly-Foster Iron-Mine, Brewster, N.Y.," by Prof. E. S. Dana; "On the Transcendental Curves sin y sin $my = a$ sin x sin $nx + 6$," by Professors H. A. Newton and A. W. Phillips; "On the Equilibrium of Heterogeneous Substances," by Prof. J. Willard Gibbs.

WE have received Part 4 of the *Transactions* of the Glasgow Society of Field Naturalists, containing an account of the proceedings for 1875-6. The part contains many valuable papers in natural history, the results of original observations, and we regret that want of space prevents us referring to them in detail.

THERE are several papers of considerable value in the last-issued part of the *Transactions* (vol. iii. No. 2) of the Academy of Science of St. Louis, and we regret that our space will admit of our giving only the titles:—"Iron Manufacture in Missouri; a General Review of the Metallurgical Districts and their Resources," by Dr. A. Schmidt; "Remarks on Canker-worms, and Description of a New Genus of Phalænidæ," by Prof. C. V. Riley, who also contributes "Notes on the Natural History of the Grape Phylloxera (*P. vastatrix*)," and "Notes on the Yucca Borer (*Megathymus yuccæ*, Walk.)"; "On a New Form of Lecture Galvanometer," by Prof. Nipher; Dr. G. Engelmann contributes "Notes on Agane (with photographic illustrations)," and "About the Oaks of the United States;" "The Rocky Mountain Locusts and the Season of 1875," by Mr. G. C. Broadhead, who also contributes papers on "The Meteor of Dec. 27, 1875," and on the "Age of our Porphyries;" Mr. A. J. Conant has a paper on the "Archæology of Missouri." The latter part of the number is occupied with the Journal of Proceedings.

IN the *Penn Monthly*, a Philadelphia publication, for May and June are two interesting articles by Mr. C. E. Dutton containing "Critical Observations on Theories of the Earth's Physical Revolution."

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus radiatus*) from India, presented by Mr. Chas. E. Green and Mr. R. K. Meaden; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Capt. J. C. A. Lewis; a Striped Hyæna (*Hyæna striata*) from Algeria, presented by Mr. Thos. Barber; an Arabian Gazelle (*Gazella arabica*) from Arabia, presented by Mr. F. de Havilland Hall; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. Geo. J. Hendry; a Common Boa (*Boa constrictor*) from South America, presented by Mr. F. B. Bloxham; a Red and Yellow Maccaw (*Ara chloroptera*) from South America, deposited; a Hog Deer (*Cervus porcinus*), born in the Gardens.

SCIENTIFIC SERIALS

American Journal of Science and Arts, September.—In a second paper on the gases contained in meteorites, Mr. Wright first describes those of the Kold Bokkeveld stony meteorite, one of a distinct class containing a good deal of amorphous carbon, a bituminous substance, and very little metallic iron. The volume of the gases obtained was much greater, but the gaseous mixture was like that of ordinary stony meteorites, except in the very small quantity of hydrogen present. A comparative table is given of the gases of seven iron and six stony meteorites. From experiments on the manner of occurrence of carbon dioxide, the author infers that while some of the gas may be condensed on the fine particles of the iron, a large portion of it and of the water, carbonic oxide, and other gases, is mechanically imprisoned in the stony substance of the meteorite. The idea is favoured of comets consisting of meteoric masses with the gases expanding under action of solar rays. Every cubic mile of a substance like the Kold Bokkeveld meteorite would give thirty cubic miles of gas at the pressure of our atmosphere, and in space this would expand enormously before it would cease to transmit electric discharges or be visible by reflected sunlight. These views are confirmed by spectroscopic observations of meteoric gases.—Mr. Storer, questioning Carius' statement that Schœnbein's iodo-starch test for nitrates used with zinc as reducing agent, is not a specially delicate one, finds that the fatal defect of the test, as hitherto applied, lies in the fact that mere water containing no nitrates or nitrites, on being treated with zinc or cadmium, as if to test for a nitrate, will react on iodo-starch just as if a trace of some nitrate were present. This coloration is due to peroxide of hydrogen formed in the water by action of the metal. Mr. Storer also finds that no peroxide of hydrogen is formed when water slightly acidulated with sulphuric acid is boiled on metallic cadmium; and as the reduction of nitrates and nitrites occurs readily in such solutions, the iodo-starch test can be thus applied for detection of nitrates with great certainty.—Mr. J. Lawrence Smith gives an account of a new meteoric stone which fell in 1865 in Wisconsin, and which is identical with the Meno-meteorite which fell in 1861.—Mr. Brooks gives a classified list of

rocks in the Huronian series south of Lake Superior, with remarks on their abundance, transitions, and geographical distribution; and Mr. Burnham furnishes a seventh catalogue of new double stars.

Poggendorff's Annalen der Physik und Chemie, No. 7, 1876.—We have here the second portion of Dr. Root's inaugural dissertation on dielectrical polarisation. He finds (1) that there is a dielectrical polarisation which takes less than 0·0000821 sec. to be perfectly developed; (2) that all solid dielectric bodies (sulphur *not* excepted) show, with continuous discharge or slow commutation, a dielectric reaction which, *e.g.*, in arragonite is perceptible within 0·0208 sec., but no longer so beyond 0·007 sec.; (3) that in direction and *relative* size the principal axes of elasticity of Fresnel agree with Maxwell's principal axes of electro-elasticity; and (4) that only with the aid of Faraday's supposition that a perfect conduction everywhere accompanies polarisation, can the equation $K = n^2$ (*i.e.*, the dielectric permeability = the square of the index of refraction) be brought into harmony with experience.—A third paper from M. Kohlrausch describes experimental researches on elastic reaction in torsion, expansion, and bending. It relates chiefly to stretching and bending of caoutchouc. The various phenomena are shown to agree with a formula previously given; and a remarkable result from his study of reaction generally is, that after successive deformations of opposite sign, movements of reaction may remain in an electric body, which may pass from one direction into the opposite.—Two methods of determining the indices of refraction of liquids and glass plates are described by M. Wiedemann.—Dr. Vogel communicates observations on the spectra of the planets. The light which all of them send us is, he considers, reflected sunlight; the well-established fact that there is aqueous vapour in the atmospheres of Jupiter and Saturn makes it improbable that they have (as has been supposed) so high a temperature as to be self-luminous. The further a planet is from the sun the more marked is the influence of the gaseous envelopes in production of spectroscopic dark bands.—M. von Rath, of Bonn, describes a number of mineralogical specimens, and M. Berthold makes a contribution to the history of the radiometer, to which we shall refer in a separate note.

SOCIETIES AND ACADEMIES

London

Entomological Society, Sept. 6.—Mr. J. Jenner Weir, F.L.S., in the chair. Mr. Edward Boscher was elected a member.—Mr. Edward Saunders exhibited some recently-captured specimens of *Hymenoptera* and *Hemiptera*, many of them rare in this country, and made some remarks respecting the bug of the house-martin, of which he had taken eighteen specimens in the window-sills of a house.—Mr. Weir mentioned that on a recent visit to the South Downs he had suffered much annoyance from the attacks of harvest bugs, as many as eighty pustules appearing on each foot. Several remedies were suggested, especially rubbing the affected parts with brandy and water; but Mr. Smith stated that on one occasion when he was in the Isle of Wight and exposed to their attacks, he was effectually relieved from all annoyance by a dose of milk of sulphur.—Prof. Westwood communicated a note with reference to some shoots of horse-chestnut which he had exhibited at the July meeting, having been destroyed, apparently, by some Lepidopterous larvæ or wood-boring beetles; but he had since received from Mr. Stainton some shoots that had been forwarded to him by Sir Thos. Moncrieffe, which had been destroyed by squirrels in precisely the same manner. Sir Thomas had himself seen the squirrels at work splitting the shoots with their teeth and extracting the pith. The Professor also stated that he had received from a correspondent in Oxfordshire specimens of the two small species of grasshoppers with long antennæ *Meconema varium*, Fab., and *Xiphidion clypeatum*, Panzer, which he had taken on a pear tree in his garden, where they had been regularly observed for the last five or six years. Mr. McLachlan said that the former insect was frequently observed by Lepidopterists when sugaring for moths.—Mr. Smith communicated the descriptions of three additional species of *Formicidæ*, from New Zealand, which had been sent to him by Mr. David Sharp since his description of Mr. Wakefield's collection was in the press. Two of the species belonged to genera not previously ascertained, to inhabit New Zealand, namely *Amblyopone* and *Ponera*.—The following memoirs were read:—"Monograph of the dipterous genus *Systropus*, with notes on the economy of a new species of that genus;" and "Descriptions of new genera and species of Acroceridæ." Both were communicated by the President, Prof. Westwood.

Boston

Natural History Society.—During the Session, 1875-6, Prof. N. S. Shaler has contributed several papers on physical geology, in one of which he attempted to account for the phenomena of several areas of glacial erosion. He is persuaded that the melting caused by pressure would put a limit to the accumulation of ice at a depth probably not exceeding two miles. This melting would give the ice-sheet a chance to move freely in the direction of least resistance. The flow of the melted water would account for stratification of moraine matter, and for the rounding of pebbles.—Mr. Osten Sacken has revised the North American species of the Dipteran genus Syrphus.—Dr. W. K. Brooks has made a contribution to the embryology of Salpa, which is startling to naturalists, and will be of great importance if confirmed. He says that in tracing back the history of the zooids composing a chain, the egg is present at all periods of growth, of exactly the same size and appearance as at the time of its impregnation. He concludes that the animal, which has no existence, cannot be the parent of the egg which is already fully formed. Thus the explanation is that the solitary salpa is the female, which produces a chain of males by budding, and discharges an egg into the body of each before birth. These eggs are impregnated while the zooids of the chain are very small and sexually immature, and develop into females which give rise to other males in the same way. After the fœtus has been discharged from the body of the male, the latter attains its full size, becomes sexually mature, and discharges its spermatic fluid into the water, to gain access to the eggs of other immature chains. This arrangement is compared with other cases, as in cirripeds, arachnids, argonaut, in which the male is to some extent parasitic on, or supplemental to, the female.—Mr. T. T. Bouvé has further developed his views of the origin of porphyries from metamorphosed conglomerates.—Dr. Brooks's paper on the affinity of the mollusca and molluscoida is worthy of note. He concludes that Brachiopods are derived from Vermes; and Polyzoa from some primordial Brachiopod. The polyzoan stem gave off the molluscan veliger, from which the true mollusca have originated by several offshoots. The scaphopods appear to be the least specialised. The Lamellibranchs may be derived from one of these offshoots: they probably diverged early from the ancestral form, becoming degraded in certain respects and specialised in others. The president, Mr. T. T. Bouvé, gave a very interesting address on March 15, describing the origin and early proceedings of the society, its struggles with difficulties and ignorance, and the stages by which it has reached its present successful position. He stated that the society's museum, as now arranged, constituted a series of lessons in the structure of the earth and its constituent parts, and in the organisation of the plants and animals on its surface. Special lectures have been given to teachers, and other efforts have recently been made by the society for the spread of science.

Rome

R. Accademia dei Lincei, February—April.—The following, among other papers, were read:—On the common origin of the Marian and Vatican hills, by M. Ponzi. They were formed by a great seismic oscillation which laid bare their entire stratigraphical arrangement. The marls at the base of the Vatican hill have yielded many organic remains representing the old sub-Apennine fauna of the upper miocene.—On alkaloids of viscera that have putrefied at a low temperature, by M. Selmi.—On the presence of organs of taste in the tongue of Saurians, by M. Todaro. Having indurated several tongues of *L. agilis* and *L. viridis*, made sections, and coloured with picrocaminate of ammonia, he found a large number of gustative organs about the papillæ on the lateral margin of the tongue. They are similar in form and arrangement to those in mammals.—On a constant inductor, by M. Volpicelli (appendix to memoir). He had described one of the nature of a Leyden jar. Another consists of a dry pile, having 10,640 pasteboard discs, each covered with sheet-tin on one side and with peroxide of manganese on the other. One pole is coated with a good insulating varnish. The other communicates with the earth. The dry pile serves usefully in verifying the laws of electric action.—On artificial increase in the tenacity of cotton, by M. Manzoni.—On the inundations of the Tiber at Rome,

by M. Brioschi.—M. Moriggia presented the famous tattooed man, Konstantinos, a native of Albania, who was long a prisoner of war in Chinese Tartary. He was then tattooed from head to foot, with figures of men, tigers, crocodiles, apes, &c. The work was continued for four months. The tactile sensibility of the skin is diminished; sensibility to thermal stimuli is good, and to electrical perhaps increased; muscular force low; a difficulty of breathing and lassitude; sense of strain and smart in the skin, greatest in the feet and seat; considerable insomnia, vision and hearing affected, frequent dysentery and abdominal pains, blood rich in leucocytes, urine with traces of albumen, free perspiration still, intelligence not much affected, *morale* depressed, &c.—Historico-critical note on the theory of the electrophorus, by M. Cantoni. His results closely agree with those of Neyreneuf.—M. Ponzi presented the second part of a catalogue of fossils found in the lower marls of the Vatican Hill (141 animal species).—Observations on the solar diameter at the Royal Observatory of Campidoglio in 1875, by M. Respighi. These confirm former conclusions.—New researches on the fine structure of the electrical plates in the torpedo, by M. Boll.—Anatomical and physiological researches on the arms of cephalopods, by M. Colosanti.—On some recent palæontological discoveries in the territory of Massa Marittima, by M. Lotti.—On Zoppi's method of cementation of cupriferous solutions in Agordo, by M. Pellati.—M. Volpicelli criticised a recent experiment of Govi's (*Journal de Physique*). An inductor is brought under two light pendula suspended from a metallic ring on insulating support. There is sudden divergence, and this increases if the induced bodies be connected an instant with the ground. If the inductor be brought sufficiently near the ends of the pendula, the previous divergence is diminished; on then suppressing the induction, the divergence increases. Govi infers the induced electricity causing the divergence to be of the first species (heteronymous to that of the inductor); M. Volpicelli says if he will examine it, he will find it to be homonymous.—M. Gastaldi presented the first part of a memoir entitled "Fragments of Italian Palæoethnology."—On the Vatican fauna (continued), by M. Ponzi.—On the non-periodical movement of a system of material points, by M. Valentino.—On strata with *Aspidocerra acanthicum*, Opp., of Sicily, and their cephalopoda.—On the porphyroid quartziferous diorite of Cossato in Biellese, by M. Cossa.—On some products of putrefied cerebral substance, by M. Selmi. He finds among these the volatile alkaloid trimethylamine.

May 7.—M. Capellini presented some fragments of *Balænotus*, found along with flint implements in the valley of Fiore, in a marl of the Lower Pliocene. In a memoir he discusses the distribution of land and water at that epoch, and offers some new views on the origin of fauna and flora of the Miocene and Pliocene formation in Italy (which origin he places in the north-west). He shows that many fossil plants found in northern regions appear in Italy in more recent formations.—On the scintillation of stars, by M. Respighi. He affirms (in opposition to Montigny) that this in its essence is independent of the quality of the light of the star. Montigny's observations regard merely the modality of the phenomenon, and the question carried into that field belongs rather to physiology than to physics. The spectroscope shows that, rigorously speaking, the variations of colour, especially in low stars, are innumerable, even in a second, and it is only by the limited power of our senses, the persistence of sensations, &c., that we succeed in perceiving distinctly a limited number of the variations, which naturally must depend on the greater or less brightness of the star, the varied proportion of rays composing its light, the means used to diminish the influence of persistence of the images, and other causes which render the eye less apt to perceive variations of colour.—On the latitude of the Royal Observatory of Campidoglio, by M. Respighi. This is 41° 50′ 33″. M. Respighi stated that the great work of revision of the declination of stars of the first to the sixth magnitude, in the zone 21° to 62° N., was well advanced, both as regards observations and reductions.—M. Volpicelli presented a second note on the machines invented by M. Belli, and called *Duplicators*.—On palæontological discoveries in the Vatican marl, which geologist refer to the Tertiary period, by M. Ponzi. He describes carbonised trunks of *Pinus sylvestris*, eaten into by an insect, which he names *Hylobium tortonianum*, resembling the *H. pini* of the present.

PARIS

Academy of Sciences, Sept. 11.—Vice-Admiral Paris in the chair. The following papers were read:—On preventive trepanation in fractures with displacement of splinters of the internal or vitreous table of the cranium, by M. Sedillot.—Note on intra-mercurial planets, by M. Leverrier.—On the recent trombe of Coinces in the Loiret, by M. Faye. This was very violent, damaging a large number of houses, and lifting and throwing many people down.—Process for detecting wines coloured artificially, by M. Lamattina. The simplest way is to mix 100 grammes of wine with 15 grammes of peroxide of manganese roughly pulverised, stirring the mixture twelve or fifteen minutes, and filtering through a double filter. If the wine is pure it passes colourless, if it retains its colour it has been coloured artificially. If the peroxide is not pure, but ferruginous, the iron is dissolved; the fuchsine, if present, forms an insoluble combination, which remains in the filter, and the filtered liquid has a slightly yellow colour. The residual peroxide is treated with alcohol, acetic acid, and ammonia.—On the orbit of the planet 12[illegible] by M. Renan.—Note on a lunar rainbow observed at Roche, commune of Saint Just (Haute-Vienne), by M. Martin de Brettes. This was at 9·50 P.M. on September 2; the day had been showery and a mist rose over the river. The centre of the rainbow was north; mean horizontal diameter about 25°, apparent width of bow 2°, colour green yellow; on close attention it was seen to be red exteriorly and violet in the interior. The bow was slightly elliptical, the vertical semi-diameter longer than the horizontal; this was likely due to the obliquity (45°) of direction of the river. The bow seemed very near, a few hundred metres off. It was enveloped by a second, 5° off.—Observation of the partial eclipse of the moon, September 3, 1876, at the Observatory of Toulouse, by M. Perrotin.—Note on the radiometer, by Mr. Crookes. He says that most of the experiments recently described to the Academy are a repetition of those he himself had made, and he has also discussed fully the various theories offered, but his researches had not become known, owing to memoirs to the Royal Society not being published in the *Philosophical Transactions* till twelve or eighteen months after presentation.—Researches on some Calamodendreæ, and on their probable botanical affinities, by M. Renault.—On a block of millstone found in the eruptive sand of the environs of Beynes, by M. Meunier. This confirms the opinion that the eruptive sand is artesian, and constitutes a vertical alluvium.—On the distinctness with which one can see the bottom of the sea from a balloon situated at a great height, by M. Moret. In an ascent from Cherbourg with M. Duruof, they observed, at a height of 1,700 metres, the bottom of the channel most clearly, though the depth there must be 60 or 80 metres. The submarine rocks and currents were distinctly revealed. This method might be utilised for purposes of navigation.

CONTENTS

THURSDAY, OCTOBER 5, 1876

THE WOUNDED IN SHOOTING

SOME time since a well-known public writer excited the surprise and anger of a large portion of the community by vehemently protesting against the amount of animal suffering caused by field-sports, and a long and rather bitter controversy ensued. Mr. Freeman's remarks were, if we recollect right, limited to "hunting," in the conventional sense of the word—that is, the chase of the fox or the hare with hounds, and many estimable persons were not a little shocked to find themselves accused of having, nearly all their life-time, been committing the grossest cruelty. Whether the principles and practice of humanity sustained any benefit by this fierce attack, whether the attack was made in the best possible taste, and whether in making it Mr. Freeman did not overlook a very important consideration (of which, by the way, we are not aware that any of his opponents took advantage), are questions we do not here propose to discuss. We are now led to make a few calculations based on the returns contained in the Eighteenth and last Report of the Board of Inland Revenue of the number of persons who take out licences to kill what the law calls "game" and to carry a gun. This Report (which we may observe is one presented to both Houses of Parliament, and can be obtained by anybody at her Majesty's Stationery Office for the small sum of sixpence) is undated, but refers to the financial years 1873-4, and 1874-5. That for the past year (1875-6) is not, we believe, published, or we would gladly avail ourselves of it. However, in the Report before us it stands that, in the year 1873-4, there were, 132,036 holders of gun licences and 65,846 holders of licences to kill game. In the year 1874-5 the corresponding numbers were 144,278 and 68,079. It would not be easy to estimate the number of "head" slain by these persons, but there is no reason why, for our present purpose, we should attempt to do so. The beast or bird killed by the gun generally dies as speedy a death as can possibly be inflicted, and the tenderest and most sentimental of hearts cannot complain on the score of humanity *quoad* the victim. But how about the wounded—which everyone knows to be many? Is it possible to estimate their number? We think it is; but let us premise that in making the computation we have no desire to harrow the feelings of our readers by a sensational description of the miseries which an animal may suffer from the lodging of one or many pellets of shot in any part of its body. In some cases they may be frightful, in others productive only of a slight degree of pain, hardly amounting to more than personal inconvenience; but in striking the balance we may, on the whole, assume that acute pain, enduring for some hours or days, is suffered by every beast or bird which the shot strikes, and the shooter does not "bag." Now as to the number of these wounded.

Recalling our own shooting days, we should say that a man must be an uncommonly good and careful shot who does not on an average wound without "bagging" more than three head of game each day that he takes the field. Many men will "lose" that number every day, and by "losing" a bird, a hare, or a rabbit, we mean that it has fallen to the gun or been hit hard enough to insure its capture, had not the retriever, the scent, or the marking been bad. But such cases bear no proportion to the numbers (of grouse or partridges especially) that are hit but not hard enough to be counted "lost." They are seen to flinch as they are struck, but that is all; away they go, whether to the next hill-side, into the next field, or much further, no one asks, and no one thinks more about them. *À la guerre comme à la guerre.* Now supposing that all who shoot game are good and careful shots, we should have on our estimate each shooter wounding his three head per diem irrespective of what he brings to bag. But all shots are neither good nor careful, therefore we think our estimate cannot be too great, and we have also to take in cases of what may be called extravagant shooting, where the numbers of wounded must transcend any ordinary computation.[1]

We have now to reckon the number of days that each holder of a game licence may be supposed to shoot. The shooting season begins for grouse on August 12, for partridges on September 1, and for pheasants on October 1. As we do not wish to be guilty of any exaggeration, but only to strike a fair average, let us take the partridge-shooting season, *i.e.*, from September 1 to February 1, inclusive.[2] Herein we have twenty-one weeks. It does not seem an immoderate assumption to suppose that each holder of a licence to kill game goes out on an average two days a week during that time. There are, no doubt, many men who get no more than two days' shooting throughout the whole season and yet take out a licence; but there must be at least as many, if not more, who are not so conscientious and run the risk of shooting for the whole season without paying the duty. The Commissioners in this very Report say (p. 18) of the Game Licence, that "while it is used by game preservers as a means of punishing poachers, there can be no doubt that among persons of a higher station in life it is very largely evaded." Then there is a very considerable number of inveterate sportsmen who go out day after day throughout the whole season—to say nothing of the grouse shooters who, as most of them pay highly for their moors, unquestionably shoot every day they can for a month or six weeks. Therefore taking the partridge season as a basis, we think that our assumption of an average of two days a week for those twenty-one weeks is not excessive This will give an average of forty-two days of shooting for each of the 65,846 holders of licences to kill game in 1873-4, and of the 68,079 in 1874-5. Now we have already shown the likelihood that each of them wounds on an average three head of game *per diem*, we therefore multiply both of these numbers by 126 (= 42 × 3) and we find that in the former of these two years there must

[1] One such very recent case we may cite from the columns of a contemporary (*The Field*, Sept 23, 1876) In nine days, between the 1st and 15th of September, inclusive, of this year, the Maharajah Duleep Singh, on his estate at and near Elveden, killed to his own gun 2669 head of game, of which 2530 were partridges. This is vouched for by his Highness's head-gamekeeper. It is true that there is only one Elveden and one Maharajah in this country, and that the fact of its being communicated to a newspaper shows that both master and man thought the slaughter rather remarkable, but instances which approach it are not altogether unknown.

[2] The Report on which we base our calculations is in one respect defective, since it does not separate the respective numbers of holders of licences for the entire year or for the half-year. Judging, however, from the amounts of duty charged, the latter are about one-fifth of the whole The majority of them are supposed to be chiefly schoolboys, and, as they are learning the art, they may be justly considered clumsy performers with the gun, wounding more than the average of adult shots.

have been 8,296,496, and in the latter 8,577,954 animals left wounded.

Then with regard to the holders of gun licences. It does not seem an excessive estimate to suppose that each wounds on an average two animals (birds, almost exclusively, in this case) a week throughout the year of fifty-two weeks. A great proportion of holders of these licences no doubt do not exercise their privilege every week. Many of them do so only with the object of protecting their crops; but the season for fruit and garden vegetables goes on all the summer, say from May to September, and the harvest lasts six weeks, while for some three weeks before that begins the corn is ripening, and is then most attractive to sparrows. A single shot into a flock of sparrows will wound many more than it kills, and such shots, as our ears tell us, are frequent during the day. It does not seem possible to place the average number of birds wounded by each holder of a gun licence lower than we have done. We have therefore to multiply the number of holders by 104 (= 52 × 2), and then we find that in 1873-4 there must have been 13,731,744, and in 1874-5, 15,004,912 animals left wounded by this class of persons.

Adding the two sets of numbers, we have a grand total for the former of these years, 22,028,2 40, and for the latter, 23,582,866 wounded; while this increase of over 1,500,000 in one twelvemonth forbids our supposing that the next Report would show much, if any, diminution.

Just as before we purposely abstained from distressing our readers by dwelling on the effects of all this wounding, so now we purposely abstain from using any strong language, or calling those who shoot by bad names. This is not meant to be a sensational article. We are sure in our own mind that sportsmen are not by nature cruel—very far from it. Yet, if we may trust our figures, here are the plain facts that acute pain of uncertain duration was, in the year ending March 31, 1874, inflicted upon *over twenty-two millions* of animals, and in the following year upon *over twenty-three millions and a half* in the British Islands. We are not aware that we possess any bias that would make us exaggerate our estimates to produce these results. Our only object is to attempt as near an approximation to the truth as we can. The figures stand for themselves, and if anyone thinks he can furnish fairer averages let him give his *data* for them. We are, as it is, willing to guard against any unconscious exaggeration and to knock off more than 10 per cent. of our grand totals, so as to say roundly that only twenty millions have suffered in each year. But we would invite our readers to reflect on the proportion which even that number bears to the number of animals which during the same time have been subjected to experiment by the physiologists of this country. The latter have been by many excellent persons held up to obloquy as monsters of cruelty. If this has been done justly what must they think of those who use the gun?

BLASERNA ON MUSICAL SOUND

The Theory of Sound in its Relation to Music. By Prof. Pietro Blaserna, of the Royal University of Rome. With Numerous Woodcuts. International Scientific Series. (London: Henry S. King & Co., 1876.)

OF the many valuable works which have appeared in the International Scientific Series, none deal with a better subject than that of Prof. Blaserna. "The student of physics," he says truly in his Preface, "does not go much into the study of musical arguments, and our artists do not sufficiently understand the very important bearing that the laws of sound have upon many musical questions."

The first three chapters of the book hardly call for detailed notice. They reproduce the familiar facts of acoustics lucidly and succinctly. Vibration, its transmission and velocity, echo, noise as contrasted with musical sound reinforcement by sympathy, sounding-boards and resonators, complete the first division of the subject. The second begins with measurements of vibration, graphically or by means of the siren. The limits of audible sounds are thus determined to lie between 16 and 38,000 per second; of the human voice between the 61 vibrations of double B is the bass, and the 1,305 of the soprano F in alt.

The importance of uniform pitch is adverted to. Its invariable rise, in the course of years, is explained by the "tendency of manufacturers of musical instruments, especially those made of brass, to raise the pitch continually, in order to give a greater brilliancy of tone to their instruments;" an indictment in which the players might justly have been included as well as the manufacturers.

The harmonic series, and its demonstration by means of the sonometer, conclude the fourth chapter. The laws of ratios, of interference, and of beats, with their resultant notes, occupy the fifth. From these the ancient Greek scale, attributed to Pythagoras, is built up, and compared with our modern scale, the youngest member of which, the minor third, "was only adopted in the seventeenth century, with many reservations, together with the harmony of the sixth, from which it can be easily derived."

Of the harmonic seventh (rather awkwardly termed throughout "the seventh harmonic") it is judiciously observed that "to an ear accustomed to our music, it may appear unpleasant; but an unprejudiced examination, according to the opinion of some—an opinion with which I entirely agree—shows that it is rather strange than unpleasant; that in certain special cases it affords very good discords and passing chords, and that the strangeness arises rather from our want of familiarity with it than from its inherent nature. Without wishing to push too far forward, and to prophecy what will happen in the future, it may be observed that the systematic introduction of the harmonic seventh into music would produce in it a very deep and almost incalculable revolution, a revolution which does not seem justifiable, because, for our magnificent musical system, another would be substituted, perhaps as magnificent, but certainly not better, and probably worse, at any rate more artificial."

Helmholtz's double siren is described at some length, and illustrated by numerical examples, carrying the student on to chords of three or more notes; the marked difference in character between the major and minor common chords being attributed to the disturbing effect of the resultant notes in the latter, which is absent in the former. Even Mozart shows "a certain reluctance to use the minor as a closing chord. It may be that the most highly gifted musical natures have, as it were, felt beforehand that which theory has since been able to explain in a simple and conclusive way." Discords and their contrast with concordant intervals lead to a comparison of music

with the other fine arts, and to a sketch of its history, which is less satisfactory than other portions of the work. The following account of Hebrew music is quaint in the extreme:—"David and Solomon were very musical. They composed psalms full of inspiration, and evidently intended to be sung. To the latter is due the magnificent organisation of the singing in the Temple at Jerusalem. He founded a school for singers, and a considerable band, which at last reached the number of 4,000 trumpeters." The "Lyre of Orpheus," and the ratios derived from its traditional four strings, are far more fully explained. The Ambrosian and Gregorian scales follow, as well as the first attempts at polyphonic music in the tenth and eleventh centuries. Guy d'Arezzo is still credited with the invention of modern notation, though he really only used "neumas" and two clef lines, or staves, one yellow and one red. Luther, who doubtless was a musician, is accepted as the reformer of music as well as of the church. The modern and Pythagorean scales are numerically compared, and then transposition and modulation lead to a description of temperament. "The temperate scale," as it is here termed, "starts with the principle of making no distinction between the major and minor tone, of confounding the major semitone with the minor, and of considering the sharp of a note as equal to the flat of the succeeding note; so that all the notes of an octave are reduced to twelve only, which are considered equidistant from each other."

The difficulties in the way of true intonation, especially in the case of keyed instruments, are fairly stated, and the writer concludes with a remark in which we cordially sympathise:—"It does not, therefore, appear impossible, or even really difficult, for the full orchestra and chorus to perform a piece of music in the exact scale."

The subject of the eighth chapter is quality or "Timbre," in which Helmholtz's views are expounded and illustrated by good diagrams of optical and graphical methods, and of Koenig's ingenious apparatus. The last section draws distinctions between music as a science and as an art, and between Italian and German music; giving a remarkably fair estimate of Rossini's position as a melodist, rather than as a scientific musician, and on the other hand a deserved tribute of praise to the lofty character and deep dramatic feeling which, "notwithstanding some too realistic exaggerations, and some trivialities," mark the compositions of Richard Wagner.

On the whole, this volume is easily and clearly written, although, as already noted, it is rather sketchy and hurried in the historical part. There are other minor typographical, or probably translator's, oversights, such as Terpandro for Terpander, Cornue for Cornu, Orlando Tasso for Orlando Lasso, and harmonicon for harmonium. But it affords a readable *résumé* of a subject which is daily rising in scientific, as well as in purely artistic interest.

W. H. STONE

TWO BOOKS ON LANGUAGE

The Existence of Mixed Languages. By J. C. Clough. (London: Longmans, Green, and Co., 1870.)

On the Comparative Method of Learning Foreign Languages. By L. J. V. Gerard. (Leicester: 1876.)

THE existence of mixed languages is one of the vexed questions of Comparative Philology. By a mixed language is meant a language in which the grammars of two or more different languages have been fused together, not one in which the vocabulary is of a heterogeneous character. Mixed languages in the latter sense are, of course, plentiful enough; in fact there are languages like the Basque or the Telugu, in which the proportion of borrowed words is larger than that of native words. But though words may be borrowed, it is a grave question whether the expression of grammatical relations can be, and modern philology has been inclined to deny the possibility of such an occurrence. The grammar of one speech may be influenced by that of another, existing machinery being adapted to express grammatical conceptions introduced from abroad, or foreign modes of forming the sentence being imitated, and the idioms of one language may even be adopted by another, but anything beyond this is extremely unlikely. It is in grammar and structure that languages differ from one another; the expression of the relations of grammar embodies the mode in which a particular community thinks, and a change in their expression is equivalent to a change in the mode of thinking. And this mode of thinking is the result of a long succession of past experiences and stereotyped habits of thought.

Mr. Clough boldly challenges the orthodox view of the impossibility of mixed languages. He endeavours to support his heresy by an appeal to contrary instances. Thus he points to jargons like the Chinook, or Pigeon-English, to languages like Maltese or Hindustani, which have grown out of jargons, and finally to independent forms of speech like Turkish or Persian, in which he believes he finds examples of mixed languages. But he does not always distinguish between mixture in the grammar and in the vocabulary, or between the borrowing of idioms and of grammatical conceptions. Hence a large part of his book, that which deals with languages like the Keltic, the Romanic, and the Teutonic, is quite beside the point. On the other hand, he has omitted to notice some very important cases of an apparently mixed grammar, such as the Pahlavi of ancient Persia, the Assamese and kindred dialects of Northern India, and the Sub-Semitic languages of Africa. A full discussion of the phenomena presented by these might lead to a modification of the orthodox doctrine, at all events so far as the flexion of the noun is concerned. As it is, Mr. Clough has brought forward a good deal of pertinent matter, though a larger amount of what has nothing to do with the question in dispute. The whole of the second part of his book, for example, which relates to English, might easily have been spared. The book, however, is full of information, and the facts collected are usually accurate.

M. Gerard has reprinted a lecture delivered by him at the Leicester Museum, on the scientific, and therefore the natural, way of learning foreign languages. The lecture is an excellent one, at once original, clear, and practical. M. Gerard is no friend to existing systems of teaching French and German, and he is undoubtedly right in his belief that their failure is due to a neglect of the way in which children learn their own or a foreign tongue. Instead of beginning by studying the rules of grammar and loading the memory with lists of isolated words, the child speaks in sentences, and only gradually learns to distinguish the several words of a sentence and the parts of

speech to which they belong. To learn to speak a foreign language by reading a grammar and writing exercises is an impossibility. We must imitate the procedure of the child, and be content to follow the same method in learning a new language that we followed when learning our own. The essence of a language is its idioms; no amount of grammatical study will teach us these. The study of grammar should come after our acquisition of a language, not before it.

M. Gerard defines his method as follows:—"We must accustom ourselves to the expression of ideas in the language we wish to learn by comparing it with their expression in our own, until we are able, through imitation and analogy, to express them in our own. In other words, we must understand the language and think in it before we use it." Understanding a language means reading and hearing it; using a language means speaking and writing it. Hence the course of study recommended by M. Gerard comprises the four distinct processes of reading, hearing, speaking, and writing, reading coming first and writing last. If reading is the primary object in learning a new language, M. Gerard's course is undoubtedly the right one, but if speaking is rather aimed at, we think it a mistake to make reading precede. What is heard will then have to be translated into the language of the eye before it is understood, and this will be a serious impediment to the learner. Moreover, a language consists in the phonetic sounds by which it is conveyed, not in the symbols whereby these sounds are expressed on paper. Learning to read should follow learning to speak, as it does in the case of children. With this single exception, we can heartily endorse all M. Gerard's recommendations; they are founded upon nature and reason, and their practical efficiency has already been proved. Especially noticeable are his remarks on the use of translations; a dictionary is desirable only when we have acquired a fair elementary knowledge of a language and its forms of expression. Language starts with the sentence, not with the isolated word.

A. H. SAYCE

OUR BOOK SHELF

The School Manual of Geology. By J. Beete Jukes, M.A., F.R.S., late Director of the Geological Survey of Ireland. Third Edition, revised and enlarged, edited by A. J. Jukes-Browne, B.A., F.G.S. (Edinburgh: A. and C. Black, 1876.)

THE late Prof. Jukes's admirable "School Manual of Geology" is already so favourably known to teachers of the science, for the clearness of its style, the accuracy of its information, and the abundance and excellence of its illustrations, that, in welcoming the appearance of a third edition of the work, we shall confine ourselves to a few remarks upon the changes which the editor has found necessary to make in it. In doing so, we have again to commend Mr. Jukes-Browne's skill in so well maintaining the distinctive characters of his uncle's work, while not hesitating to introduce such new matter as is demanded by the progress of the science.

In revising the chapter on igneous rocks, the editor acknowledges the assistance he has received from the Rev. T. G. Bonney. The principle of classification which he adopts—that, namely, of grouping the rocks, not according to one set of characters only, but on the basis both of their mineralogical constitution and their minute structure—we consider unexceptionable. To some of the definitions adopted in this chapter we must however demur, as for example to those of andesite, porphyrite, and diorite, in all of which the essential felspar is stated to be *oligoclase*. As petrographers are not in possession of any ready means for determining the exact variety of felspar in a rock, in the absence of a complete chemical analysis of it, such a distinction becomes almost entirely useless in practice. Most continental writers avoid this difficulty by applying the same general terms to all such rocks as are shown, by microscopic examination or otherwise, to have any variety of the plagioclase felspars as their predominant constituent. We must also confess to grave doubts as to whether the revival of the obsolete term *leucilite* is warranted either by necessity or convenience.

In respect to that long-vexed question of geology, the limit between the Silurian and Cambrian systems, we think that Mr. Jukes-Browne has exercised a very wise discretion. He has in the present edition adopted the judicious compromise between the claims of Murchison and Sedgwick, which was long ago suggested by Lyell and Phillips, and has received such able support from the researches of Salter and Hicks. If convenience and scientific truth are not to be wholly sacrificed to the desire to do homage to the memory of an individual, it is quite time that the aggrandised empire of Siluria should be resolved into its proper elements, and that these should resume their due place in the brotherhood of formations.

In introducing some necessary changes into the chapter on the Glacial period, the editor has wisely avoided too hastily adopting any of the crude speculations which have recently been advanced on the subject. The statement, however, that the till of Scotland is of *older* date than the boulder clay of the English Midland Counties surely stands in need of some modification.

We heartily congratulate the editor and publishers of this very useful little manual on the well-merited success which it has attained.

Geology: its Influence on Modern Beliefs. Being a Popular Sketch of its Scientific Teachings and Economic Bearings. By David Page, LL.D., F.G.S. (Edinburgh and London: William Blackwood and Sons, 1876.)

UNDER the above title Dr. Page has published two essays which are devoted to an exposition of the chief scientific results, and a vindication of the economic value and importance, of geological research. The somewhat rhetorical style of these essays is sufficiently accounted for by the fact that they were originally prepared by their author as popular lectures for an Edinburgh audience—a disposition of them which was frustrated by his ill-health. Dr. Page has very effectively grouped, and eloquently sustained his several theses, while many of the chief points of his discourses are rendered more telling by admirably chosen illustrations from the immediate neighbourhood of the city in which the lectures were to have been delivered. In one or two instances, however, we notice that the author has not succeeded in avoiding the danger of making his generalisations of too sweeping a character—as for example when he informs us, without any qualification, that "men need not search for the veined marbles of the metamorphic rocks in tertiary beds, for metalliferous veins in secondary strata, nor for workable coal-seams in the Old Red Sandstone and Silurian systems."

The Law of Storms Considered Practically. By W. H. Rosser. (London: Chas. Wilson, 1876.)

WE have read this little book with very great pleasure, and can strongly recommend it to the navigator as giving briefly, but pleasantly and intelligently, an account of the history of the law of storms, down to the present time, inclusive of the various theories which have been propounded. The book is also to be commended as evincing throughout a remarkable justness of criticism, of which

he criticism on Prof. Blasius' recent book on storms may be cited as an illustration, and a close adherence to its ext, viz., storms practically considered.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Force

In his valuable lecture on force at Glasgow, reported in Nature, vol. xiv., p. 459, Prof. Tait did great service by insisting on the duty of precision and consistency in the use of this as of other scientific terms, and showed clearly how the word "force" may be used precisely and consistently. My reason for troubling you with this communication is that I am unable to identify this use of the word with Newton's, on the assumption that the English equivalent for Newton's *vis* is "force."

As the same difficulty has probably occurred to other readers of Nature, I should be glad if Prof. Tait would kindly tell us through your columns what are the equivalents in English for the phrases (1) *vis*, (2) *vis insita*, (3) *vis impressa*, each of which is used in Newton's "Principia."

In the phrase *vis insita*—if *force* is the English for *vis*—is not a meaning of the word "force" implied which is wider than and inclusive of the meaning of *vis impressa?* P. T. Main

An Intra-Mercurial Planet

The discussion as to the existence of a planet within the orbit of Mercury leads me to communicate an observation made many years ago, which I believe nothing but the existence of an unknown planet between us and the sun can explain. On Sunday, January 29, 1860, the sun rose in a fog in London, so that he could be steadily looked at as if through a dark glass. Soon after eight o'clock a perfectly round black object was seen by four persons, including myself, clearly defined upon the lower half, according to my recollection, of the sun's disc. It passed slowly across his face and made its egress at about half-past nine A.M. In apparent size it was equal to the representations I have seen of Mercury in transit. F. A. R. Russell

Pembroke Lodge, Richmond Park, September 30

Brilliant Meteor

The brilliant meteor of September 24 was well seen in the neighbourhood of Ipswich, and as the observation of it was difficult in the absence of stars, the following notes may be useful. It was first seen at 6h. 31m. 15s. L.M.T., and the train was visible as a luminous cloud until 6h. 47m. 3s. L.M.T. The course had a length of about 25°, which was described in three seconds, and made an angle of 80° with the horizon. By means of the train which it left behind, it was possible to fix the point of disappearance with considerable accuracy, namely: altitude, 14° 6′; azimuth reckoned from south towards east, 54° 16′. At this time Saturn was visible, having an altitude of 10° 56′, azimuth 53° 15′.

For purposes of description the course may be divided into three portions, roughly equal. In the first portion the meteor had a uniform brightness somewhat greater than a first magnitude star, but during the second portion it rapidly increased to many times the brightness of Venus, and almost suddenly diminished to its former magnitude. In the third portion it again increased in brilliancy, considerably exceeding its former maximum, and was suddenly extinguished without bursting. This third portion only was marked by the train estimated about 6° long, with a scarcely perceptible breadth. During the sixteen minutes that the train was visible it drifted about 12° northwards, losing gradually its definite outline. Direction of wind, south-south-west.

The diameter of the disc was certainly not greater than 2′, and the form was pear-shaped, though not very prolonged, leaving the observer with the idea that the peculiarity of form was merely due to the persistence of the impression on the retina. It is very difficult to estimate its maximum brightness accurately, as the heavens afford us no object with which to compare it. I have recently shown that Venus has only $\frac{1}{810}$th part of the light of the full moon, and there is no other standard of light with which to bridge over this gap. If the moon had only a diameter of 2′, its intrinsic lustre would be 240 times greater than it is, and the intensity would probably be such as would cause the observer involuntarily to avert his eyes when seen suddenly, even in full twilight; still, I do not think the meteor had much less light than such an object would have. The glare was of the colour, and closely resembled, a very vivid flash of lightning, for which it was mistaken by many persons.

John I. Plummer

Orwell Park Observatory, September 27

The Age of Palæolithic Man

In the extremely interesting communication on this subject which Mr. Skertchley has made to Nature, vol. xiv. p. 448, there are one or two points on which I should like to say a few words.

First, in approaching this subject and endeavouring to find out the whole truth let us in starting have nothing but the truth. A human bone, a fibula, was certainly found beneath glacial clay in the Victoria Cave at Settle, but so far *no implements* have turned up from that ancient horizon. This is a simple inadvertence which does not in any way affect the strength of Mr. Skertchley's position, but I am anxious to correct it and as it were strangle it at the birth lest cuckoo-like it should shoulder kindred but legitimate statements out into the cold.

Mr. Skertchley's remarkable discovery consists in the finding of palæolithic implements beneath the great chalky boulder clay of Mr. Searles V. Wood, jun., which is the so-called East Anglian upper boulder clay, and this, as Mr Skertchley says, and as I believe Mr. Searles Wood holds, and with which I certainly agree, is probably as old as the Lancashire lower boulder clay or till. And this Lancashire till is undoubtedly of the same age as the till of Scotland, as all authorities admit. Moreover this till is generally admitted to be the product of the great ice-sheet of Scotland and the North of England. We are therefore landed at the conclusion that implements have been found in beds which are probably of earlier age than the Scottish ice-sheet, a conclusion in which I cannot but heartily concur. Mr. Skertchley does not state this directly, but I presume this is the legitimate inference to be drawn from his statements, and one which he would himself admit.

There can be no doubt that this is very strong and corroborative evidence of the general views so ably urged by my friend, Mr. James Geikie, that all palæolithic implements and the fauna associated with them are of inter-glacial age. It may seem captious after having been led to the battle by so able a general, and having driven the enemy so far already, to grumble at his stopping short in the pursuit, yet such is the object of my present remarks. And I would wish to point out that there are heights, or rather depths, which may yet be advantageously scaled to the further discomfiture of the foe.

Mr. J. Geikie has not ventured to carry the age of the bulk of the palæolithic beds further back than the time immediately *succeeding* the great Scottish ice-sheet. He appears to regard the "great submergence" which followed this as the chief cause for the removal from certain areas of the remains of men and animals which peopled them in inter-glacial times. "The palæolithic gravels of the south-east of England . . . are contemporaneous with those ancient valley-gravels of Scotland which overlie the till and boulder-clay, and which are themselves partially re-arranged and covered with marine deposits belonging to the time of the great submergence."[1] He certainly once "puts his hand to the (ice-) plough." "No doubt, however, portions . . . especially in the districts south of the Thames, may date back to the earlier warm periods of the glacial epoch, and thus be contemporaneous with the fresh-water beds in the Scottish till; while some may go back even to pre-glacial ages;" but he immediately "looks back" to the sea of the great submergence as the great destroyer of palæolithic records. "After the great ice-sheet shrank back and the till and boulder clay had been deposited, a land-surface existed, rivers flowed down the valleys, and plants and animals clothed and peopled the country. In Scotland the fluviatile deposits belonging to that period have been subjected to great denudation, but in one place at least they have yielded animal remains, frogs and water-rats. But if the country had never been submerged after the withdrawal of the ice from the low grounds, there is good reason to believe that the presence of the relics of palæolithic man and remains of the animals with

[1] "The Great Ice Age," pp. 482-9.

which he was associated would have occurred in the valley-gravels of Scotland, Ireland, and the northern and midland counties of England, just as in those of the south-east." Mr. Geikie makes a similar statement in his preface :—"A wide land-surface existed in the British area after the disappearance of the ice-sheet and before the period of great submergence;" and he cites the discovery of the human fibula under glacial clay in the Victoria Cave in confirmation.

It has always seemed to me that in discarding the power of the ice-sheet for that of the "great submergence" as an agent for the removal of all traces of an earlier fauna, Mr. Geikie, when attacking the tree of prejudice, has cast down his axe and taken up a whittle. Apart from the very doubtful extent and depth of the submergence, its destructive powers cannot for completeness be compared to that of the grinding of an ice-sheet. In a submergence, even if the beating of the surf destroyed all superficial deposits—a supposition which, if applied, a coast so abounding in land-locked and sheltered firths as Scotland partly submerged would present, is in the highest degree improbable—the rivers at least would carry down carcases into secure resting-places and entomb them in estuary mud, and it would be most unlikely that no such relics should be preserved when the land rose again. But, on the other hand, it is difficult to believe that any organic remains could escape the grinding of an ice-sheet if continued through a long period.

In the Victoria Cave, at any rate, the surroundings are such that nothing but an ice-sheet could have sealed up with glacial clay the remains discovered by the Committee. The valley lies close by, but is 900 feet deeper, and no advance of a mere valley glacier in the supposed later increase of glacial conditions could have brought the boulders to that height. The form and situation of the hill near the top of which the cave lies is such, that no small ice-field could have formed on it and brought this glacial *débris*. The origin of the boulders, their position, the ice-scratches on the rocks hard by, all point to the time of greatest glaciation when the whole district probably was covered in with ice and snow of great thickness. And the agent which closed the cavern and concealed the animals within it must have been the same which swept the country clean of their remains all around further than the eye can reach.

To sum up, the direct evidences as yet found to support, by actual infraposition, the inter-glacial age of palæolithic man and of the fauna with which he is associated, are as follows :—

1. Victoria Cave, Settle :—A *human fibula* under glacial till, and associated with *Elephas antiquus*, *Rhinoceros leptorhinus*, Hyæna, Hippopotamus, &c.[1]

2. At Wetzikon, Canton Zurich, a piece of lignite containing *basket-work* lying beneath glacial deposits, and associated with *Elephas antiquus* and *Rhinoceros leptorhinus*.[2]

3. Near Brandon, Suffolk, *implements*, with bones not yet determined, in brick-earth beneath the great chalky boulder-clay of East Anglia.

There is nothing in any of these instances to support the notion that this particular fauna lived subsequently to the age of the Scottish ice-sheet and immediately prior to a great submergence.

The Settle till is undoubtedly of the age of the ice-sheet. The Wetzikon lignite lies upon a glacial till beneath a river gravel, and upon that are huge angular erratic blocks, "clearly indicating the presence of a great glacier posterior in date to the organic remains."[3]

The Brandon implements are beneath the chalky boulder clay which Mr. Searles Wood, jun., believes to be the product of an ice-sheet, though partly deposited beneath the sea, a condition which is incompatible with the co-existence of a great submergence.

After, and in sole opposition to, such evidence, we can hardly contentedly take the existence of frog and water-rat as upholding the presence of palæolithic man and his congeners in times later than the great ice-sheet of Scotland. The Arctic mammals are, of course, out of court and cannot be taken as evidence, for it is highly probable that they returned with the retreat of the ice; but, so far, we have no evidence that this was the case with the more tropical animals.

My friend Mr. James Geikie will, I am sure, take these suggestions in the friendly spirit in which they are offered. My chief reason for bringing them forward is that we hear that a new edition of his valuable work is in preparation, and it will be a loss to geology if this matter be not fully discussed by one who is so well able to handle the subject in all its bearings. Meanwhile, we are deeply indebted to him for progress already made, and also to my friend Mr. Skertchley for this important addition to the evidence and the perspicuous manner in which he has brought it before us. R. H. TIDDEMAN

[1] "The Relation of Man to the Ice-sheet in the North of England," NATURE, vol. ix., p. 14, 1873; also "Settle Caves Exploration," Brit. Assoc. Reports for 1874 and 1875.

[2] Rütimeyer; *Archiv für Anthropologie*, 1875; also NATURE, vol. xiii. p. 130.

[3] Lyell; "Antiquity of Man," p. 368.

The Flame of Chloride of Sodium in a Common Coal Fire

SOME time ago a correspondent of NATURE (vol. xiii. p. 287) inquired for an explanation of the fact that while common salt (chloride of sodium) colours the flame of an ordinary spirit-lamp yellow, the same substance thrown upon a common coal fire gives rise to a blue flame. In the next number (p. 306) Dr. Schuster stated that the origin of the blue flame was still involved in mystery, and (if my memory is correct, for I have not the number at hand) that he and Prof. Schorlemmer had been engaged in an investigation of the same.

Dr. Schuster's letter shows that the question is not an unimportant one; and as I have lately made a few experiments which seem to confirm an explanation which occurred to me at the time, I send a short description of them.

The theory I put forward is that the blue flame noticed when salt is thrown upon a coal fire (of bituminous coal) is possibly due to the presence of *carbonic oxide* (CO), produced by a series of reactions, through which the common salt is converted into, first, sulphate, and then sulphide of sodium, as in the manufacture of crude carbonate of sodium (*black ash*), all the reactions being simply carried out in one furnace instead of two.

Leblanc's process consists in—1. Converting common salt into sulphate of sodium. 2. The "salt cake" is then mixed with coal and limestone, placed in a furnace and heated strongly, during which process *a blue flame of carbonic oxide is observed to play upon the surface.*

Now in the case we have under consideration, the only difference is that the salt is first converted into sulphate by the oxidation of the iron pyrites, from which no coal is free (and, in fact, it has been proposed to use such a process commercially, viz., by roasting common salt with iron pyrites).

At this stage, then, the reaction going on in the fire will be expressed by the equation—

$$4NaCl + 2FeS + O_{11} = 2Na_2SO_4 + Fe_2O_3 + Cl_4.$$

Almost simultaneously with this, the carbon of the coal comes into play, reducing the sulphate of sodium to sulphide, thus—

$$Na_2SO_4 + C_4 = Na_2S + 4CO \text{ (carbonic oxide).}$$

Of course were any substance present answering to the limestone used in practice, as may occur in the ash, we should have the full conversion to "black ash," viz. :—

$$6Na_2S + 8CaCO_3 + C_2 = 6Na_2CO_3 + 6CaS + 2CaO + 4CO,$$

with a further evolution of carbonic oxide.

I need not say that carbonic oxide burns with a violet blue flame perfectly indistinguishable from that produced by throwing salt into a *bituminous* coal fire. This may be proved at once by experimenting with a fire of *anthracite*, which itself only gives the slight lambent blue flame of carbonic oxide. The presence of salt makes no difference whatever in the colour of this flame, and it is difficult indeed to determine whether the salt is ignited at all. The difference in the two cases is just this :—A common coal fire has usually a large, bright, or smoky flame. Salt thrown on it diminishes its size and brightness by robbing it of free carbon or hydrocarbon—which gave it those qualities, and which is derived from the volatile matter—as in the reactions above set forth, the result being the production of carbonic oxide. In the case of anthracite, however, the free carbon is absent; but the carbonic oxide exists, and is equally apparent before and after the addition of salt. It is possible that the heat, instead of volatilising the sodium compounds and so giving the yellow flame, is expended in effecting the new chemical transformations.

In the case of a spirit-lamp or of a Bunsen burner there is no supply of carbon, nor is there any iron pyrites to be converted into sulphuric acid, consequently the above complicated process cannot take place, and the flame only shows the sodium coloration.

The following laboratory experiments were made with a view to test the accuracy of these speculations :—

1. A little common salt was placed in a crucible, inclosed in a jacket, and exposed to the Bunsen flame. The fringe of flame appearing above the crucible was of course coloured most intensely yellow.

2. A similar arrangement was made, only that the crucible contained a mixture of common salt and powdered charcoal. Although the crucible was heated to a redness, the flame had lost most notably its intense yellow colour and occasionally a slight blue tinge appeared around the edge. This last I do not lay much stress on, as it might be merely due to the Bunsen flame; but the diminution of the sodium colour could not be overlooked.

3. The crucible was now filled with a mixture of salt and powdered charcoal, together with a very little of sulphide of iron (in fact, the substance used for the preparation of sulphuretted hydrogen), and exposed over the Bunsen burner as before. In this case the sodium coloration almost completely disappeared, while the blue flame became very distinct indeed.

No difference could be observed, whether the air was turned on or off the burner, in these experiments.

When the above mixtures were exposed on platinum wire in the naked flame, they only gave the sodium colour. This is doubtless to be ascribed to the stronger heat volatilising some of the sodium salt before it had time to enter into the necessary changes. This is the more likely, because mixtures made with just the slightest trace of salt gave the yellow colour in the naked flame, while the mixtures used in the crucible as described, and which gave the blue colour, contained fully 50 per cent. of salt.

Dr. Schuster, in the note already mentioned, refers to a paper by Dr. Gladstone (*Phil. Mag.*, 1862, vol. xxiv., p. 417), on the similar behaviour of certain metallic chlorides in imparting a blue or violet colour to flames of various kinds. I find that in this paper the violet colour given by the chlorides of potassium, sodium, and barium, in the flame of red-hot coals is noticed, Dr. Gladstone remarks, however, that "a doubt must rest on such observations made with a common coal fire, as it is quite conceivable that these chlorides may give up their chlorine to the alkalies or earths of the ash.

It struck me that it would have some bearing on the matter, to ascertain if other salts of sodium exhibit the same phenomenon. On trial I find that there is no difference.

A little pure sulphate or carbonate of sodium thrown on a coal fire produces exactly the same blue flame as common salt, both with ordinary coal and with anthracite. These salts, in the flame of the Bunsen or the spirit-lamp, give the strong yellow flame of sodium at once. It is clear that their behaviour on hot coals is explainable in exactly the same way as that of common salt, viz., by the production of carbonic oxide. It is inferable, therefore, that the blue flame of common salt is not to be ascribed solely to some property inherent in chlorides alone; and the solution I have proposed seems the more plausible.

A correspondent in NATURE suggested the probable formation by a reaction between common salt and *copper pyrites* in the coal, of chloride of copper, and that the last would give the blue flame. However, it is iron pyrites, and not copper pyrites, that occurs in coal; and, moreover, the flame of copper chloride is bluish green, and not blue. EDWARD T. HARDMAN,

Kilkenny Her Majesty's Geological Survey

OUR ASTRONOMICAL COLUMN

THE INTRA-MERCURIAL PLANET QUESTION.—Notwithstanding the suspicious aspect of the spot remarked upon the sun's disk by Weber at Peckeloh, on the afternoon of April 4, 1876, as it is described by him in his letters to Profs. Heis and Wolf, it would appear that it must be relegated to that class of ordinary solar spots which are better defined than in the majority of cases, and continue visible but a short time. A letter has been addressed to the Abbé Moigno by Señor Ventosa, of the Observatory at Madrid, containing a very definite observation of a spot on that day which was evidently the one noticed at Peckeloh. A similar letter to Prof. Peters is published in *Ast. Nach.*, No. 2106.

It is not, perhaps, generally known in the astronomical world that the systematic observation of the sun's disk forms one of the routine subjects to which attention is directed at the Madrid Observatory. The observations are made daily with the large Merz-Equatoreal, projecting the image of the sun upon a screen so as to present one of considerable diameter. The heliographic positions of the spots are determined on the method adopted by the late Mr. Carrington on the image projected by the finder, which is provided with a suitable reticule, and, whenever possible, their distances from the limb are measured directly with the large telescope. The drawings are made by hand.

After noon on April 3 the sun was without spot, a group of *faculæ* only being visible very near the S.W. limb. But on the morning of April 4 there was a small spot, a simple nucleus without penumbra, of an apparently elliptical figure, with a small *facula* on the N.W. side (puro nucleo sin penumbra, de figura eliptica aparentemente, y con une fácula pequena por el lado N.O.); this was very well observed. Cirrus was scattered over parts of the sky, but the images were well defined. The observations gave the following results:—

April 3 at 22h. 9m. 54s. M.T., at Madrid, angle of position of the spot, 76° 43′, distance from the centre of the disc 818″·9, the sun's semi-diameter being taken at 960″·9. At 22h. 24m. direct measure of the distance of the spot from the sun's limb gave 147″, consequently 814″ for the distance from the centre. The dimensions of the spot were 4″ × 2″.

April 5, after noon, the sun was again without spot; the most remarkable object was a bright *facula* very near the N.E. limb. It will be seen that the first Madrid observation was made 5h. 7m. previous to that at Peckeloh.

The opinion expressed by M. Leverrier before receiving the Madrid observation, that certain problematical solar-spot observations upon record might accord with a revolution of an intra-mercurial planet in about twenty-eight days, in which case an inferior conjunction might fall on the 2nd or 3rd of the present month, has been construed into a definite prediction of a transit of the so-called *Vulcan*, on one of those days, a prediction which M. Leverrier distinctly repudiates, though it has been widely circulated by the daily press in and out of France. The rejection of the observation of April 4 in the present year leaves us in doubt again as to what period will correspond to the most reliable data, assuming the existence of an inter-mercurial planet.

Mr. Wray's observations about midsummer, 1847, and others of hardly less authority, require explanation. It is impossible to repudiate them, but whether referable to the passage of planetary or cometary bodies, must remain for future decision.

THE VARIABLE STAR, ALGOL.—The following are Greenwich times of visible geocentric minima of Algol to the end of the year, calculated from the elements in Prof. Schönfeld's latest catalogue of variable stars:—

	h. m.		h. m.
Oct. 20	16 42	Dec. 2	16 55
23	13 21	5	13 44
26	10 20	8	10 33
29	7 8	11	7 22
Nov. 12	15 13	22	18 38
15	12 2	25	15 26
18	8 51	28	12 15
21	5 40		

THE MINOR PLANETS.—It appears by a telegram from Vienna in the Paris *Bulletin International*, of September 23, that Herr Palisa, of the Observatory at Pola, has recovered No. 66 of the group of small planets—Maia—detected by Mr. Tuttle, at Cambridge, U.S., though at some distance from the position given in the *Berliner Jahrbuch* for 1878.

The following names are proposed for recent discoveries:—No. 165, discovered August 9, 1876, Loreley; No. 166, August 15, Rhodope; No. 167, August 28, Urda. Nos. 168 and 169 are announced; the former was detected by Prof. Watson on September 27, and the latter by M. Prosper Henry on the following night near the same position. Both are eleventh magnitudes.

THE RADIOMETER IN A BALLOON

THE Count Elemer Bathyani made a private ascent in the *Tricolore* balloon on Monday, August 28, with Duruof as an aëronaut. The balloon started from La Villette Gasworks at 11.50 in the morning, and descended at Chevru, near Coulomiers, about forty miles from Paris, at 2 o'clock, after having run little short of a hundred miles. The aerial craft had been overtaken by a series of winds in different directions. The culmination of the ascent was 2,500 metres.

The objects of Count Bathyani were to rotate the radiometer at different altitudes, so as to illustrate the augmentation of the luminosity of the sun, and to condense the vapour of clouds with an ether evaporator, in order to collect moleculæ suspended in the air, and ascertain whether vapour was mixed with a certain quantity of ammoniac, nitrous or nitric compounds, or ozone. The last operation could not be executed, because the balloon did not meet a true cloud, having passed in the superior zone through lacunæ, between the several cumuli. But the radiometer experiments were successful, and we are enabled to give a correct table of the results obtained. The radiometer was blue-red, constructed by Gaiffe.

In the Shade.—On the ground (at La Villette), 35 revolutions per minute, with a pressure of 750 mm., sky half covered by disconnected cumuli, temperature, 26° C., at an altitude of 1,750 meters.

In the *Tricolore* floating between cumuli at a distance of 1,500 metres from the earth, sixty-four rotations per minute—temperature, 15°.

In the Sun.—Time 11h. 50m. Temperature 18°, altitude 700 metres, sun shining through a layer of clouds fifty-four rotations per minute. Time 1h. 10m. Altitude 2,300 metres, temperature 13°. Sun shining; it is impossible to measure the number of revolutions, which are as great, if not greater, than with an ordinary white-black radiometer exposed to a radiant sun at the surface of the earth.

M. Gaiffe is constructing another differential radiometer to rotate under similar circumstances. One of the faces is to be white, and the other white with a black spot in the centre. The evaporator was working with ordinary vinic ether, but with methylic the condensation will be a great deal more powerful. The water in suspension will be precipitated under the form of ice; the refrigeration of condenser being then 20° C. below zero, all the dust floating in the air in the vicinity of condenser will be deposited with the ice. The ice is to be collected and ultimately analysed micrographically as well as chemically.

The difficulty is to prepare a vessel for holding the methylic ether, as the pressure is enormous even at ordinary temperature. But I was told at Auteuil frigorific works it can be obtained and filled ready for use very easily at a comparatively small expense.

W. DE FONVIELLE

THE RECENT TORNADO

IT is evident from a correspondence in the *Times* of Friday, Saturday, and Monday last that a tornado of almost unexampled intensity and destructiveness swept over the Isle of Wight and Hampshire on the morning of Thursday, September 28. The storm, which appears to have come from a southerly direction, struck West Cowes about seven in the morning, thence crossed the Solent in a north-easterly direction, and, striking the opposite coast, near the entrance of Southampton Water, passed up Hampshire between Titchfield and Portsmouth at least as far as Meonstoke, which is about sixteen miles to the north-east of Cowes.

Its appearance on approaching is described as that of an immense black cloud sweeping along the ground and giving out a low moaning sound which it was awful to hear. A gentleman in a small yacht, which fortunately was out of the course of the tornado, suddenly heard sounds very much resembling the noise caused by the escape of steam when at its highest pressure, and at the same time the whole sky became clouded with articles of all forms and sizes which were carried through the air to a height of about 300 feet and parallel with the shore. The Globe hotel was blown down, and several houses lost their roofs, fronts, or chimneys; a pier belonging to Dr. Kernock was wholly demolished, and many of the watermen's boats were sunk, being filled with bricks which had been blown through the air. It is stated that some bricks fell on board Lord Wilton's steam yacht, the *Palatine*, which was moored half a mile from the shore. At Cowes alone the damage done, the work of only one short minute or two is estimated at from 10,000*l.* to 12,000*l.* The destructive character of the tornado was maintained in its course through Hampshire, where turnips and other crops were literally dragged out of the ground, fine oak trees uprooted, farms and homesteads damaged, a barn being bodily lifted up, and instantly converted into a heap of ruins, and life lost. It made a clean sweep through a thick copse, clearing a path for itself 100 feet in width, along which the trees and underwood were all uprooted, as if men had grubbed up everything. In some cases it is said that the corners of ricks and cottages were cut off as if with a knife, and that iron pig-troughs were carried a distance of 300 to 400 yards, and gates lifted from their hinges and thrown into the adjacent fields.

Since the mode and suddenness of its approach, its brief continuance, and its terrible destructiveness, all show that in investigating this storm, it is a true tornado we are dealing with, we hope that, whilst the occurrences are fresh in the minds of those who witnessed them, some one will take the trouble to make a careful collection of the facts. As yet, little of the meteorology of this tempest is before us; what is required for its investigation is to know along different points of its track the time it began and ended, the changes in the direction of the wind, temperature, and state of the sky, and the aqueous precipitation accompanying it; the damage done, the objects whirled aloft, and the direction and course taken by them in their flight through the air. A careful investigation of the facts of this tornado would form a valuable contribution to meteorology at the present time, inasmuch as it would probably enable us to say whether tornadoes and other whirlwinds are to be regarded as typical, as is sometimes alleged of the cyclone of tropical regions and of the ordinary storms which sweep over these islands.

The services of a sufficient staff of observers are more urgently required to record non-instrumental observations of wind, rain, hail, cloud, &c., from which the broad features of wind storms, hail-storms, and thunder-storms could be adequately described, and some knowledge arrived at as to the way in which the rainfall is propagated from parish to parish. If such organisations were set on foot over different portions of the British Isles, we should soon be in a position to attack several of the more important practical problems of meteorology, and to issue weather-warnings in the interests of agriculture and horticulture as began to be issued in France some months ago.

Storms seem to have been wandering widely recently. Ten days before the tornado above referred to, a storm of unusual violence visited the American coast, and the Paris *Temps* received on Saturday evening a telegram from the Puy-de-Dôme Observatory stating that a terrific hurricane had been blowing since the morning. It was impossible for the observers to walk outside the house without being blown down. The velocity of wind could not be registered by anemometer. The sky was clear, but clouds were covering the surface of the earth and clinging to the different mountains. On the following night and day the weather was boisterous and rainy at Paris.

THE PUY-DE-DÔME OBSERVATORY

WE have already given some information concerning this important meteorological observatory, and to-day we present three illustrations showing its site and construction.

The site of this observatory is 1,465 metres above the level of the sea and about 1,000 metres above the level of Rabanesse, the meteorological station connected with it and situated in the gardens of the Clermont Faculty of Sciences. The Puy-de-Dôme was in ancient times supposed to have been the scene of so-called Druidical sacrifices, and was certainly the seat of a Roman temple, probably of Mercury. In excavating the mountain for the foundation of the observatory the extensive ruins of this temple were again brought to light. A number of medals, statues, and other objects have already been found and collected in a special museum. But it is intended to replace them in a repository which is to be built on the very top of the mountain.

It was on September 19, 1648, that Perrier, the then president of the Cour des Aides, verified on the top of the Puy-de-Dôme the great law of the diminution of pressure discovered by his brother-in-law, Pascal. Descartes says somewhere that he had suggested the experiment to Pascal. The illustrious philosopher was then an exile at Stockholm, where he died a few years afterwards. He was keeping up correspondence through Father Mersenne with a number of French *savants*, and especially with Perrier. Comparative observations for obtaining the height of the mercury were carried on during the years 1649, 1650, and 1651 at Clermont, at the Couvent des Minimes at Stockholm in the palace of the queen by Descartes, and after his demise by one of his friends, and at Paris by an observer whose name has not been preserved.

FIG. 1.—View of the Ruins of the Roman Temple beside the Puy-de-Dôme Observatory.

The idea of building an observatory on the Puy-de Dôme was originated by M. Alluard, the present director, about fifteen years ago. It was supported first by M. Duruy, the Minister of Public Instruction, under the Empire. M. Faye, then on a tour in the capacity of general inspector, approved it, and reported favourably. The astronomer paid more than one visit to the Puy-de-Dôme to ascertain the practicability of the proposal, which was supported also by M. Leverrier.

Up to the present moment the Government have paid only the expenses for the instruments, the whole of the costs of building having been supported by the Department and city of Clermont. The expenses have amounted to 10,000*l.*

The distance from Clermont to the Puy-de-Dôme is about ten kilometres, six of which can be done in a cart. A [illegible] made at the expense of the Department, and with very little difficulty; the track of the old *via Romana* had only to be followed.

Commandant Perrier, Director of the French Ordnance Survey, has established a barracks close to the observatory for determining, by electricity, the latitude of the Puy-de-Dôme. He will continue his work as long as the state of weather permits. For such observations the Puy-de-Dôme is connected telegraphically with Mount Souris.

The observatory, as we have already intimated, was inaugurated on August 22, during the meeting of the French Association at Clermont. Eight hundred persons made a pilgrimage to the top of the Puy-de-Dôme, to be present at the opening, and in spite of the unfavourable state of the weather, the ceremony was successful. Under an enormous tent a collation was provided for the visitors, and after the repast, many pleasant congratulatory speeches were made. M. Bardoux, president of the General Council, in speaking eloquently of Pascal, whose name is intimately associated with the Puy-de-Dôme, announced that the Government intended to erect a bronze statue to the great philosopher, in Clermont. Dr.

Janssen spoke in the name of the Meteorological Society of France, described the celebrated experiment which Pascal made on the mountain and the barometer which he used, and showed what science owes to the observations made with this precious instrument. He at the same time announced that the Meteorological Society had awarded to M. Alluard a first silver medal. Many other eloquent speeches were made, in all of which reverential reference was made to the immortal Pascal.

The observatory consists of two distinct parts—the house of the keeper and the meteorological building. The former comprises, first, the telegraph office, from which messages are sent to the station on the plain, and alongside of which are apartments for the keeper, who has

FIG. 2.—Puy-de-Dôme Observatory on the Day of its Inauguration, August 22, 1876.

been chosen by M. Alluard from the navy. On the first floor are apartments for the director, and several rooms reserved for *savants* who may wish to sojourn on the

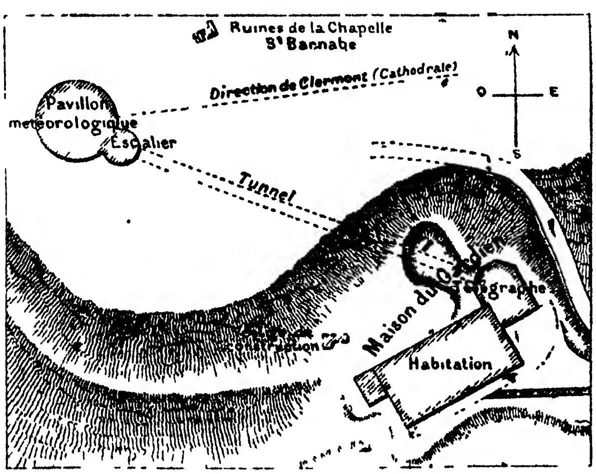

FIG. 3.—Plan of the Puy-de-Dôme Observatory.

summit of the peak to carry on observations. The body of this building communicates with the meteorological building by a subterranean tunnel. The latter building comprises an underground floor built above a vault, and another upper story which is on a level with the summit of the peak.

Traversing the tunnel from the house of the keeper, we reach the lower part of the meteorological building; this is a vault into which the light of day does not penetrate. It is intended for the magnetic chamber, and will be kept dry by a thorough ventilation, the walls being covered with cement. The first floor above this, is also underground, but is provided with two holes, by which the light enters. It constitutes a circular chamber, surrounded by a corridor, for the purpose of enveloping it in a layer of insulating air. Here will be placed the apparatus, the regular working of which requires a constant temperature, and among which we may mention Redier's registering barometer. The upper story, as we have said, is level with the ground, and forms a beautiful building, provided with four windows, adjusted to the four points of the compass. It communicates with a small external louvered cage, containing the various classes of thermometers. Inside are the following instruments:—(1) M. Hervé Mangon's anemograph, communicating by electric wires with the Robinson anemometer, placed on the top of the fixed mast on the upper part of the tower; (2) Mangon's register or pluviometer; (3) M. Hasler's thermohygrograph; (4) Fortin's and Tonnelet-Renou's barometers; (5) regulating clock; (6) astronomical telescope. This portion of the building is furnished with tables placed between each window.

Independently of the observations recorded by the registering apparatus, the keeper makes observations

every three hours, transmitting them by telegraph to the station on the plain. These observations on the summit and those on the plain are compared conjointly with the message which arrives at midday from the Paris Observatory. On these are based the meteorological bulletin of the department.

The station on the plain at Rabanesse is installed in a house provided with a quadrangular tower of 15 metres in height. It is provided with a large shelter for the thermometers, and M. Alluard has had a fine photographic studio constructed, in which he intends to organise a regular service for photographing clouds. Other ingenious and beautiful arrangements have been made here, and the entire establishment, on mountain and plain, is one of the most complete in existence, and may be expected to furnish much valuable meteorological data.

For the illustrations we are indebted to our French contemporary, *La Nature.*

ON THE APPARATUS EMPLOYED BY THE LATE MR. GRAHAM, F.R.S., IN HIS RESEARCHES[1]

MR. GRAHAM will probably be best remembered as a chemist, although the most important of his researches where either purely physical, or were devoted to the elucidation of questions which occupy an intermediate position between physics and chemistry. It is specially interesting, therefore, to observe what was the nature of the apparatus he employed in obtaining results of such importance as those with which his name is associated.

Fig. 1.

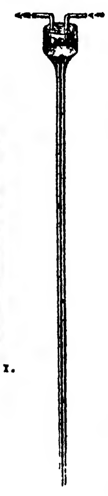

Fig. 2.

From the fact that the instruments on the table are those with which he arrived at all his more important conclusions, it will at once be evident that the appliances he used were both few and simple. Before I proceed to describe them, I should, as the time at my disposal is very limited, briefly state that Graham's labours were mainly devoted to ascertaining the nature of molecular movement in cases in which he was satisfied that no *mass* movement could take place, and, as Dr. Angus Smith has pointed out, while Dalton showed the relative weights of the combining quantities, Graham showed the relative magnitude of groups into which they resolve themselves. It is interesting to note that, as Prof. J. P. Cooke has observed, while Faraday was so successfully developing the principles of electrical action, Graham, with equal success, was investigating the laws of molecular motion. Each followed with wonderful constancy, as well as skill, a single line of study from first to last, and to this concentration of power their great discoveries are largely due.

The Royal Society's Catalogue of papers shows that his earliest paper was on the absorption of gases by liquids. It was published in 1826 in Thomson's "Annals of Philosophy"; in it he considers that gases owe their absorption in liquids to their capability of being liquefied, and therefore that solutions of gases in liquids are mixtures of a more volatile with a less volatile liquid. He concludes the paper by saying, that "All that is insisted on in the foregoing sketch is, that when gases appear to be absorbed by liquids they are simply reduced to that liquid inelastic form which otherwise, by cold or pressure, they might be made to assume, and their detention in the absorbing liquid is owing to that mutual affinity between liquids which is so common." It was a theoretical paper only, and no apparatus was even described; I have quoted it merely because, in his last paper in the *Phil. Trans.*, more than thirty years afterwards, he speaks of the liquefaction of gas in colloids in much the same terms.

In 1829, the *Quarterly Journal of Science*[2] contains his first paper on the diffusion of gases; he found that the lighter a gas is the more quickly it diffuses away from an open cylinder. The cylinders he employed were nine inches long, and 0·9 inches interior diameter; they were placed in a horizontal position, and the gas under examination was allowed to diffuse outwards through a narrow tube directed either upwards or downwards according as the gas was heavier or lighter than air. It was therefore

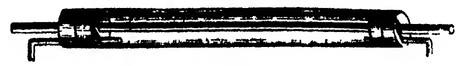

Fig. 3.

by the aid of a simple cylinder that he was led to believe, as he states in this his first paper, "that the diffusiveness of gases is inversely as some function of their density, apparently the square root of their density." He subsequently found that so great is the tendency of gases to diffuse into one another, that this mixture or inter-diffusion will take place through apertures of insensible magnitude. And in his paper in 1834,[1] he treats in detail of diffusion through porous septa, his object being "to establish with numerical exactness the following law of diffusion of gases:—The diffusion or spontaneous intermixture of two gases in contact is effected by an interchange in position of indefinitely minute volumes of the gases, which volumes are not necessarily of equal magnitude, being, in the case of each gas, inversely proportional to the square-root of the density of that gas." He started from the well-known experiment of Döbereiner, who found, in 1825, that hydrogen kept in a glass receiver standing over water, escaped by degrees through the fissure into the surrounding air, the water in the receiver rising

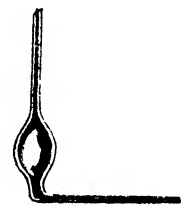

Fig. 4.

Fig. 5.

Fig. 6.

Fig 7.

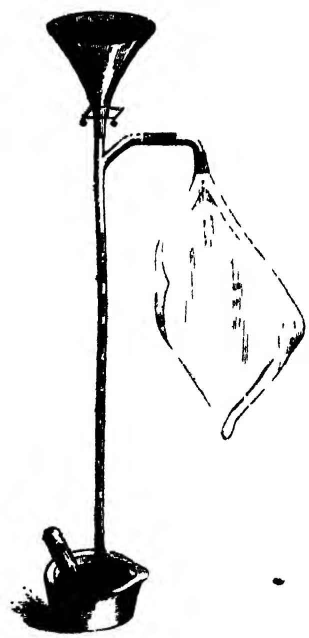

Fig 8.

[1] Lecture by W. Chandler Roberts, F.R.S., Chemist of the Mint, at the Loan Collection, South Kensington.

[2] Quart. Journ. Sci., ii. 1829, p. 74.

[1] Edin. Roy. Soc. Trans., xii., 1834, p. 222.

to the height of about 2⅝ inches above the outer level. In repeating Döbereiner's experiments and varying the circumstances, Mr. Graham discovered that hydrogen never escaped outwards by the fissure without a certain portion of air penetrating inwards, but with this essential difference, for every volume of air which penetrated into the vessel 3·8 volumes of hydrogen escaped.

The apparatus consisted of a graduated glass tube nearly an inch in diameter, having one end closed by a porous diaphragm of plaster of Paris. This tube was filled with the gas to be examined, and the rise of the mercury indicated the rate at which the interchange of gas and external air took place. He also interposed a bulb two or three inches in diameter between the diaphragm and the graduated tube with a view of increasing the capacity of the instrument, and of avoiding the interference of vapour. In this paper he traced the relation which diffusion bears to the mechanism of respiration, but time will not permit me to consider this question.

These early results were repeated and greatly extended in a paper "On the Molecular Mobility of Gases,"[1] but in the experiments there described, thin plates of compressed graphite were principally used. The paper is chiefly remarkable for the clear enunciation of the fact that diffusion is a molecular, and not a *mass* movement, for Mr. Graham observes: "The pores of artificial graphite appear to be so minute that gas in mass cannot penetrate the plate at all. It seems that molecules only can pass, and they may be supposed to pass wholly unimpeded by friction, for the smallest pores that can be imagined to exist in graphite must be tunnels in magnitude to the ultimate atoms of a gaseous body. The sole motive agency appears to be that intestine movement of molecules which is now generally recognised as an essential property of the gaseous condition of matter.

"According to the physical hypothesis now generally received, a gas is represented as consisting of solid and perfectly elastic spherical particles or atoms, which move in all directions and

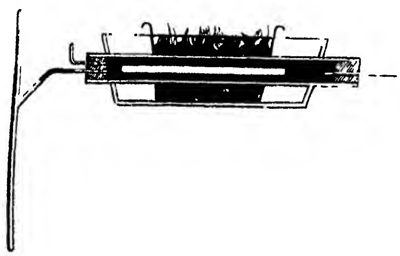

FIG. 9.

are animated with different degrees of velocity in different gases." . . . If the vessel containing the gas "be porous like a diffusiometer, then gas is projected through the open channels by the atomic motion described, and escapes. Simultaneously, the external air is carried inward in the same manner, and takes the place of the gas which leaves the vessel. To this atomic or molecular movement is due the elastic force, with the power to resist compression possessed by gases."

In order to demonstrate the diffusion of gases it is necessary to exaggerate the conditions of Mr. Graham's experiments. Instead of employing a tube closed with a disc of plaster of Paris, it is better to fix a glass tube into a battery cell and to employ it as the septum through which the gas is diffused. The following experiment was also shown:—A porous battery cell was attached to the short tube of a wash-bottle, both tubes being previously turned upwards; when a jar of hydrogen was placed over the battery cell, the gas diffused through the cell, and the change of pressure caused the water to issue like a fountain several feet in height. I believe this arrangement was devised by Prof. Bloxam.

Now I must ask you to follow me a step further. In 1846 Mr. Graham read a paper before the Royal Society "On the Motion of Gases." He showed that the *effusion* of gases through a minute hole in a platinum plug left no doubt of the truth of a general law that different gases pass through minute apertures in times which are as the square roots of their respective specific gravities, or with velocities which are inversely as the square roots of their specific gravities; or in other words, he experimentally verified the mechanical law that the velocity with which a gas rushes into a vacuum through such an aperture, is the same as that which a heavy body would acquire in falling from the height of an atmosphere, composed of the gas in question, of uniform density throughout. The relative rates of *effusion* and diffusion are alike, but Mr. Graham is careful to observe that the phenomena are essentially different in their nature. The former affects masses of gas, the latter (diffusion) only affects molecules.

[1] Phil Trans., 1863.

The apparatus Mr. Graham employed consisted of two glass jars; the one containing the gas to be examined was placed in a pneumatic trough, and the other stood on the plate of an air-pump. They were in connection, a series of tubes containing the usual reagents for purifying and drying the gas being interposed between them. The jar on the air-pump was exhausted, and the gas entered it through a minute orifice in a platinum disc, the rate of passage being observed by the aid of a mercurial column.

Three years later Mr. Graham published a paper giving the results of an investigation on what he considered to be a fundamental property of the gaseous form of matter, which he termed transpiration. He employed capillary tubes, and found that effusion and transpiration differed widely;[1] "for if the length of the tube is progressively increased, and the passage for all gases becomes greatly slower, the velocities of the different gases are found to diverge rapidly from their effusion rates." The velocities at last, however, attain a particular ratio with a given length of tube and resistance, and preserve the same relation to each other for greater lengths and resistances, the most simple result probably being that of hydrogen, which has exactly double the transpiration rate of nitrogen, the relation of these gases as to density being as 1 : 14.

	Diffusion Velocities.	Effusion Velocities.	Transpiration Velocities.	Rates of Passage through Caoutchouc.
Hydrogen ...	3·83	3·613	2·066	4·73
Oxygen ...	0·9487	0·950	0·903	2·274
Nitrogen ...	1·0143	1·0164	1·030	0·870
Carbonic acid	0·812	0·821	1·237	11·819
Carbonic oxide	1·0149	1·0123	1·034	0·968
Marsh gas ...	1·344	1·322	1·639	1·869
Air	1·0	1·0	1·0	1·0
	About 9600 c.c of air pass per minute through 1 sq. metre of stucco 2·5 mm. thick	78·3 c.c. of air pass per minute through a certain small aperture in a brass plate.	62·9 c.c. of air pass per minute through a glass tube 6·6 metres long and 0·55 mm in diameter.	16·9 c.c. of air pass per minute through one square metre of caoutchouc 0·02 mm. thick.

Note.—It is impossible to make the four columns strictly comparable on account of the difference of the conditions under which the experiments were made.

Thus, in what are very nearly Mr. Graham's own words, a gas may pass into a vacuum in three different modes; that is, by effusion, transpiration, or diffusion, and I hope you will bear with me while I recapitulate them.

1. The gas may enter the vacuum by effusion, that is, by passing through a minute aperture in a thin plate, such as a puncture in platinum-foil made by a fine steel point. The relative times of the effusion of gases *in mass* are similar to those of the *molecular* diffusion, but a gas is usually carried by the former kind of impulse with a velocity many thousand times as great as is demonstrable by the latter.

2. If the aperture of efflux becomes a tube, the effusion rates are disturbed. The rates of flow of different gases, however, assume again a constant ratio to each other when the capillary tube is so elongated that the length exceeds the diameter by at least 4,000 times. The transpiration rates appear to be independent of the material of the capillary; they are not governed by specific gravity, and are indeed singularly unlike the rates of effusion. The ratios appear to be in direct relation with no other known property of the same gases, and they form a class of phenomena remarkably isolated from all that is at present known of gases.

For instance it will be seen by the table already given that the rate of carbonic acid which is low for effusion and diffusion, becomes comparatively rapid when the gas passes by transpiration.

3. A plate of compressed graphite, although it appears

[1] Phil. Trans., 1849, p. 349.

to be practically impermeable to gas by either of the two modes of passage just described, is readily penetrated by the agency of the molecular or diffusive movement. The times of passage through a graphite plate into a vacuum have no relation to the capillary transpiration times of the gases, but they show a close relation to the square roots of the densities of the respective gases, and agree with the theoretical *times of diffusion* usually ascribed to the same gases.

These latter results were obtained by the graphite diffusiometer of which a sketch is given (Fig. 1). It stood over mercury, and was raised or lowered by an arrangement introduced by Prof. Bunsen.

Mr. Graham subsequently employed the barometrical diffusiometer shown in Fig. 2. It consists of a tube in which a Torricellian vacuum could be produced. The upper end was closed by the porous septum, and a slow stream of the gas under examination was allowed to pass over the plate through the india-rubber hood by which it was covered.

I might mention that the very exact and illustrious experimenter, Prof. Bunsen, was led to doubt the accuracy of Graham's law of the diffusion of gases, but he employed plugs of plaster of Paris which impaired the results by introducing the phenomenon of transpiration; and probably also as Mr. Graham observed to me, by an actual retention of hydrogen in the pores of the plaster It is interesting from our point of view, because it shows that the simple apparatus employed by Mr. Graham really gave the only trustworthy results.

The results of the later experiments led him to prove that mixed gases might be separated from each other by diffusion. Stems of tobacco-pipes were employed, arranged inside a glass tube, which could be rendered vacuous, the mixed gases being passed through the tobacco-pipe. For example, when this explosive mixture of 66 per cent. of hydrogen, and 33 per cent. of oxygen is passed through this tube (Fig. 3) a mixture is obtained containing only 9·3 per cent. hydrogen, and is therefore non-explosive. With air it was found possible to concentrate the oxygen by 3·5 per cent.

With the apparatus now before us (Fig. 4) Mr. Graham subsequently worked on liquid transpiration in relation to chemical composition. He started from the discovery of M. Poiseuille, that a definite hydrate of one equivalent of alcohol with six equivalents of water is more retarded than alcohol, containing either a greater or a smaller proportion of water. The rate of transpiration depending upon chemical composition and affording an indication of it, it thus appeared probable that a new physical property might become available for the determination of the chemical constitution of substances, and the experiments appeared to establish "the existence of a relation between the transpirability of liquids and their chemical composition. It is a relation analogous in character to that subsisting between the boiling point and composition so well defined by Hermann Kopp." [1] The apparatus consists of a strong glass jar closed at the top by a brass plate into which a condensing syringe is screwed. This plate also had a tube screwed into it, and into the tube the glass bulb with a long capillary tube was fixed. The fluid under examination was placed in the bulb, which communicated freely with the interior of the jar, containing compressed air.

To revert to the chronological order. His next paper in December, 1849, formed the Bakerian lecture of the Royal Society. It was on the *Diffusion* of liquids, and the only apparatus employed was very similar to that adopted in his earliest paper on the diffusion of gases; it consisted of a bottle and glass jar (Fig. 5), the fluid under examination being placed in the bottle, which was immersed in the water with which the jar was filled. With this simple apparatus he found that when two liquids of different densities, and capable of mixing, are placed in contact, diffusion takes place between them much in the same manner as between gases, except that the rate of diffusion, which varies with the nature of the liquids, the temperature and the degree of concentration is slower. Common salt when placed in the inner vessel will diffuse twice as rapidly as sulphate of magnesia, and this salt will diffuse twice as rapidly as gum arabic. Subsequently Mr. Graham modified the disposition of the apparatus and simply introduced the salt to be diffused by means of a pipette to the bottom of a jar filled with water. These experiments led to the very remarkable and important discovery that different compounds might be separated from each other by diffusion, and this was not all, for it was proved that a partial decomposition of chemical compounds was effected by diffusion. Thus ordinary alum was partially decomposed into sulphate of potassium and sulphate of aluminium, which is less diffusible than the first-named salt. Mr. Graham considered this research to be very important, and he remarks, "in liquid diffusion we appear to deal no longer with chemical equivalents or Daltonian atoms, but with masses even more simply related to each other in weight." We may suppose that the chemical atoms "can group together in weights which appear to have a simple relation to each other. It is this new class of molecules which appear to play a part in solubility and liquid diffusion, and not the atoms of chemical combination."

[1] Phil. Trans., 1861, p. 373.

Continuing the investigation he described in a paper of singular beauty, his well-known experiments on the varying rates of liquid diffusion of various soluble substances, which led him to divide them into crystalloids and colloids, the former having a rapid diffusion rate, the latter being marked by low diffusibility. He placed the substance under experiment in a tambourine of parchment paper (Fig. 6) which was floated on the surface of a comparatively large volume of water, the highly diffusive crystalloid passed through the membrane, the colloid remained behind, for "the diffusion of a crystalloid appears to proceed even through a firm jelly with little or no abatement of velocity."

I have here the very interesting series of colloids prepared by Mr. Graham, and of these perhaps the most interesting is the soluble silicic acid. If silicate of soda is poured into diluted hydrochloric acid, the acid being maintained in large excess, a solution of silicic acid is obtained. But this solution also contains, in addition to the silicic acid, chloride of sodium, from which it may be freed by the action of dialysis, and by this means a solution, which is not in the least viscous, is obtained, containing 14 per cent of silicic acid. The coagulation of the silicic acid is effected, however, by the addition of a solution containing the $\frac{1}{10000}$th part of any alkaline or earthy carbonate. Mr. Graham therefore described this gelatinous state as the "pectous," as distinguished from the "peptous" or dissolved form.

By a similar process Mr. Graham obtained specimens of soluble alumina, peroxide of iron, chromic oxide, and stannic acid, all of which have their pectous and peptous states. And he showed that in most cases alcohol, sulphuric acid, and glycerine can replace part of the water of these colloids. I cannot describe these interesting substances now, nor can I do more than remind you of the use of dialysis in medico-legal inquiries. I must content myself with summing up a few of Mr. Graham's conclusions with reference to crystalloids and colloids. Although chemically inert, in the ordinary sense, colloids possess a compensating activity of their own, arising out of their physical properties. While the rigidity of the crystalline structure shuts out external impressions, the softness of the gelatinous colloid partakes of fluidity, and enables the colloid to become a medium for liquid diffusion like water itself. Another and eminently characteristic quality of colloids is their mutability, as fluid colloids often pass from the fluid to the pectous or gelatinous condition under the slightest influences. The colloid is, in fact, the dynamic state of matter, the crystalloid being the statical condition. The colloid possesses *energy*, and it may be looked upon as the primary source of the force appearing in the phenomena of vitality."

The next instruments to be considered are those with which Mr. Graham studied osmotic force. When a solution of a salt, or a liquid, is separated by a membrane or porous diaphragm from a mass of water, a flow of liquid takes place from one side of the septum to the other. This action was discovered by Dutrochet, and is known as osmose. Dutrochet and Mr. Graham both used a narrow glass tube, having a funnel-shaped expansion at the bottom, covered at that end by a piece of bladder (Fig. 7). Mr. Graham also used porous earthenware and albuminated calico.

In some cases the flow of liquid into the bulb is sufficiently powerful to sustain a column of water many inches high in the glass tube. Dutrochet inferred from his experiments that the velocity of the osmotic current is proportional to the quantity of salt or other substance originally contained in the solution. He attributed the action of the septum to capillarity, but Mr. Graham ultimately considered that the water movement in osmose is "an affair of hydration and dehydration of the substance of the membrane or other colloid septum," and that the diffusion of a saline solution only acts by affecting the hydration of the septum. The outer surface of the membrane being in contact with pure water, tends to hydrate itself in a higher degree than the inner surface does, the latter surface being supposed to be in contact with a saline solution. When the full

hydration of the outer surface extends through the thickness of the membrane and reaches the inner surface, it there receives a check. . . . The contact of the saline fluid is thus attended by a continuous catalysis of the gelatinous hydrate, by which it is resolved into a lower gelatinous hydrate and free water. Now this question of hydration is perhaps the most remarkable instance of the persistent continuity of Mr. Graham's work, as Dr. Odling has pointed out,[1]—"it is noteworthy that for him (Mr. Graham) osmosis became a mechanical effect of the hydration of the septum; that the interest attaching to liquid transpiration was the alteration in rate of passage consequent on an altered hydration of the liquid, and that the dialytic difference between crystalloids and colloids depended on the dehydration of the dialytic membrane of the former class of bodies only."

I must now direct your attention to a section of Mr. Graham's work, which, although it was the last, was a reversion to some of his very earliest experiments. In 1829, under the title, "Notice of the Singular Inflation of a Bladder," he described the following experiment:—A bladder two-thirds filled with carbonic acid was introduced into a bell jar filled with carbonic acid gas; after the lapse of some hours the bladder was found to contain 35 per cent. of carbonic acid, and to have become distended. Mr. Graham observes:—"M. Dutrochet will probably view in these experiments the discovery of endosmose acting upon aeriform matter as he observed it to act on bodies in a liquid state. Unaware of the speculations of that philosopher at the time the experiment was made, I fabricated the following theory to account for them:—The jar of carbonic acid standing over water, the bladder was moist, and we know it to be porous. Between the air in the bladder and the carbonic acid without there existed capillary canals through the substance of the bladder, filled with water. The surface of the water at the outer extremities of these canals being exposed to carbonic acid, a gas soluble in water would necessarily absorb it. But the gas in solution . . . permeated the canal, and passed into the bladder and expanded it."[2]

You will remember that in the concluding experiments on the diffusion of gases Mr. Graham employed a tube, closed with a graphite disc (Fig. 2), in which a Torricellian vacuum could be produced. In his experiments on the penetration of different gases through membranes the same apparatus was employed, only the disc of graphite was replaced by a film of india-rubber. He found that gases penetrated to the vacuous space at the rates given in the last column of the table (p. 512). You will observe that the gas which penetrates most rapidly is carbonic acid, and you will also see that the rates of passage are in no way connected either with those of diffusion or transpiration.

A comparison of the relative rates of passage of oxygen and nitrogen led to a most remarkable experiment. Oxygen penetrates 2½ times as fast as nitrogen, therefore by dialysing air Mr. Graham actually increased the quantity of oxygen from 20·8 to 41 per cent., just as he had effected, by the aid of a tobacco-pipe, a partial separation of oxygen from air by the slightly greater diffusion velocity of nitrogen. The Torricellian vacuum was ill adapted for the experiments, and Mr. Graham gladly availed himself of the mercurial exhauster devised by Dr. Hermann Sprengel, and he considered that without the aid of this instrument it would have been impossible to conduct certain portions of the research. He was thus able to use larger septa of india-rubber, bags of waterproof silk being found to be most convenient (Fig. 8). The vacuum was not even absolutely necessary, for the penetration of the nitrogen and oxygen of air through rubber into a space containing carbonic acid could be readily effected, the gas being absorbed by potash at a certain stage of the operations.

Mr. Graham considered this penetration to be due to an actual dissolution of the gas in the substance of the india-rubber, for, as he observes, "gases undergo liquefaction when absorbed by liquids and by soft colloids like india-rubber," words I think of interest, when we remember that the sentence only marks a slight extension of the view he expressed in his first paper in 1829.

These discoveries led Mr. Graham to inquire whether it was probable that the discovery of MM. Troost and Deville of the penetration of red-hot platinum and iron tubes by hydrogen, could be due to an actual absorption and liquefaction of the gas in the pores of the metal, and by submitting the question to the test of experiment it was proved that such an absorption did take place.

[1] Lecture on "Prof. Graham's Scientific Work," Royal Institution, January, 1870.

[2] Quart. Journ. Sci., 1829, p. 88.

For instance, palladium was found to act as platinum only in a more marked manner. A tube of palladium when attached to the mercurial exhauster did not allow hydrogen to pass in the cold, but when heated to redness in an atmosphere of hydrogen the gas passed through the walls of the tube at the rate of 4,000 cubic centimetres per square metre in an hour (Fig. 9). This led to the remarkable discovery of the absorption or occlusion of gases by metals. It was found that nearly all metals appear to select one or more gases. Silver, for instance, absorbs many times its volume of oxygen, and under certain circumstances gives it out again on cooling. Iron is specially characterised by its absorption of carbonic oxide, but it also retains hydrogen, and this fact led Mr. Graham to extract from meteoric iron, the gas that probably affected its reduction to the metallic state, and which certainly exists in the atmosphere of certain stars.

The most remarkable results were obtained with palladium. I called your attention at the beginning of the lecture to the index which you will observe has moved six inches.

I will now describe the apparatus; it consists of a tall jar filled with acidulated water; at the bottom of the jar two wires are fixed, and these wires are parallel throughout the entire length of the jar. Each is attached to the short arm of a lever, the longer arms of which are about five feet long. One wire is of palladium, the other of platinum, and they form the electrodes of a small battery capable of decomposing the water. The palladium now forms the negative electrode, and is freely absorbing hydrogen, the excess of which is escaping from its surface. The absorption of hydrogen has been attended by a considerable expansion, as is shown by the fall of the index. The index attached to the platinum wire has of course remained stationary.

This expansion enabled Mr. Graham to calculate the density of the gas in its condensed form, and for reasons which I cannot give you now he was led to believe that hydrogen gas is the vapour of a white magnetic metal of specific gravity 0·7.

Now by taking palladium which has been charged in the manner you have seen, and heating it *in vacuo*, I can actually extract and show you the hydrogen it contained. This little medal of palladium contains an amount of gas condensed into it which would be equivalent to a column of gas more than a yard high, and of the diameter of the medal.

The story of Mr. Graham's work has been much better told by Odling, Williamson, Hofmann, and Angus Smith, but what does it teach us from a point of view of a collection of scientific apparatus? Surely that, although in certain researches or for accurate observation and measurement, delicate and complicated instruments may be necessary, the simplest appliances in the hands of a man of genius may give the most important results. Thus we have seen that with a glass tube and plug of plaster of Paris, Mr. Graham discovered and verified the law of diffusion of gases. With a tobacco-pipe he proved indisputably that air is a mechanical mixture of its constituent gases. With a tambourine and a basin of water he divided bodies into crystalloids and colloids; and obtained rock crystal and red oxide of iron soluble in water. With a child's indiarubber balloon filled with carbonic acid he separated oxygen from atmospheric air, and established points, the importance of which, from a physiological point of view, it is impossible to overrate. And finally, by the expansion of a palladium wire, he did much to prove that hydrogen is a white metal.

GERMAN EXPEDITION TO SIBERIA[1]

"WE stayed in Lepsa until May 17. We obtained some varieties of lizards, one kind of frog, and a toad, a kind of fish like the barbel, and all sorts of varieties of cobitis, but no salmon. We obtained only a few beetles and butterflies, but we had a rich collection of the flora. On May 13 and 14 we made a short excursion into the mountains and found several new kinds of birds differing decidedly from the European kinds, *e.g.*, the *Cinclus leucogaster*, with the white belly, the *Motacilla personata*, the *Pica leucoptera*, a fine Carduelis, and a splendid specimen of the red-finch.

"On May 15 we made a long excursion to the Dschasyl Kul (green lake), 6,000 feet above the level of the sea. The abundance of trees and bushes has a most agreeable effect, and above all is the mild red and pink of the wild apple-tree (*Pirus Sieversianus*) pleasing to the eye. The lake, lying amongst high

[1] The second letter dates from Saissan, in Russian Turkestan, May 27, 1876. Continued from p. 359.

mountains covered with snow, is surrounded by beautiful fir and other trees. We threw out our dredge but without success, neither did we see any large game, *e.g.*, steinbok or maral. The maral is a kind of stag entirely different from ours, with immense antlers, which are very rarely to be obtained, as they are considered a delicacy by the Chinese, who eat these antlers before they are quite developed, *i.e.*, in their soft, hairy state. For a pair of antlers scarcely eight inches high, the Kirghiz asked twenty rubles.

"On May 17 we left Lepsa and turned again towards the lake Ala Kul, this time to its east side. While crossing the height that closes the valley of Lepsa on the north, we mounted a peak whence we had a most beautiful view, especially of the high distant Ala Tau with its cones covered with eternal snow. On the 18th we descended into the steppe after having once more camped in yurts upon the mountains; it began to be very warm. The road leads through the steppe; it is for the greater part covered with reeds, and shows everywhere traces of boars, so we guessed to be near the lake, which we reached towards night. Numerous cranes, ducks, pelicans, gulls, and other water-fowl and moor-fowl animated the shore.

"On the 19th our road led through a grass-steppe covered with hemlock and rhubarb, and interspersed with bare alkali-soil; near the rivers were numerous 'auls' of the Kirghiz, with herds of cattle, and here and there showing some cultivation rendered possible by artificial irrigation; the Kirghiz understand perfectly the methods of damming and irrigating. Towards evening we reached the village Uidshar inhabited by Cossacks and Tartars, and continued our journey on the 20th, accompanied by a picket of twelve Cossacks from Bagti, who for ten days had been awaiting our arrival. The steppe was here by no means monotonous, it was even rendered picturesque by the view of snowy mountains around. Perhaps larks, in six or seven varieties, are the commonest birds here, besides these the black-headed wag-tail, the red-throated tit-lark, steppe-fowl, bustards, and cranes: of these mostly *grus virgo*. Wild geese (*Anser cinereus*) animate the steppe in great numbers, wherever there is stagnant water. We find our house-sparrow near the solitary yurt camp, and the swallow (*Hirundo rustica*) tries continually to build her nest on the top ring of the yurt. Where the grass is higher the quail is to be seen, and our cuckoo belongs to those birds which first greet the early morn. Everywhere we found the *Charadrius gregarius* single; the females already bringing out their young ones, are so tame that they allow you to approach within ten steps. Here we saw for the first time the saiga antelopes; they were unfortunately too shy and kept out of range. Late at night we arrived in Bagti, a clean but small military village, with barracks and soldier's houses; on May 21 we entered the Celestial empire, and advanced towards Tschugutschak, only twenty-one versts from Bagti. We passed over a hillock and the town was lying before us; we saw the brown clay walls of low, flat houses, little differing in colour from the steppe. We passed through the narrow streets, and the many-cornered bazaar (partially roofed) to the houses of the Governor-general (Dschansun) Djun, the great Barrack; all along our road we were followed by the astonished-looking faces of strange, queer figures. At the gate we had to get off our horses and, according to Chinese custom, ask permission to enter; we were then received at the hall-door by an elderly gentleman of about fifty, and introduced to his general. It was very hard to keep up a conversation, as every word had to be translated from Chinese into Kirghisian, Russian, and German, and *vice versâ*; on the whole the old gentleman treated us with the well-known speeches of Chinese politeness, placing everything at our disposal, &c. We went to see the bazaar, which contained little really Chinese ware, and so we bought nothing worth mentioning; from there we went into the quarter of the Tartars and had a very good dinner with a rich Tartar, whose very pretty wife, picturesquely dressed, presided. Tamar ...ey, our Kirghisian friend, a Mahometan, had to remain outside. The governor kindly offered to provide night-quarters but ... declined, and proceeded on our journey before evening; we ...re told that the nearest yurts were only eighteen versts dis...t, and so I too determined to ride in spite of my great fatigue. ...nfortunately the yurts were thirty versts distant instead of ...hteen, moreover the Cossack who accompanied me lost his ...y and so we arrived after having done thirty-five versts.

"We rested now for thirty-six hours and then went on with ...gas, but could not get on very quickly on account of the ...nse heat (100° F. at noon in the sun and 108° F. in the ...).

"The road to Saissan led over a steppe more than 3000 feet high, bordered on both sides by mountain ranges. We were still on Chinese territory, yet near small, rapid mountain streams, we passed here and there yurt camps of the Kirghiz and Kalmucks, Russian subjects who pasture their herds quietly on Chinese ground and grow oats and rye by help of Chinese irrigation; they are unmolested by the owners of the land or the 'Tungans,' who are mortally afraid of everything called Russian. Late in the evening of May 24 we reached a plateau high up in the mountains, and rested the whole of the 25th, enjoying the cool refreshing mountain air. The place is called Bugutusai, and is a frontier picket. During summer there are twenty-five Cossacks stationed here who have to chastise immediately any inroads of the 'Tungans.' There is always a post on a pretty high mountain, whence there is a good view far into China, as far as the snow-covered heights of the Urkandscha mountains. Not far from there are great heaps of stones, the remains of Chinese frontier posts, the garrisons of which were killed this spring by the Tungans. Near our place was a small river in which were crab-like animals. Towards evening came Dr. Pander from Saissan; he is the son of the famous anatomist who, together with d'Alton, published valuable atlases; besides refreshments he brought letters, the first which we obtained since leaving St. Petersburg. We started again early on the morning of the 26th, and descended into a plateau bordered for about fifty versts by the northernmost range of the Tarbagatai. The steppe consisted nearly throughout of gravel and stony soil hardly covered with plants; it was the most monotonous steppe we had seen so far with the exception of the pure salt steppe. The mountains by which it was surrounded gave it the appearance of a pleasant picture, but the heights danced in the heated air in a most fantastic way. After having crossed the plateau we found Aarantassas awaiting us; they brought us towards evening into Saissan, where we were most hospitably received in the house of Major Techanoff, the chief of the district who had accompanied us hither from Lepsa. The road was very good, but leads uninterruptedly through bare ravines in the fantastically weathered slate and green but treeless cones of mountains down into the steppe of the black Irtish, bordered at the horizon by the dim snowy heights of the Altai. As soon as we reached the plain we found ourselves on the regular post-line with its verst poles. Saissan is only a military post and consists of small neat-looking houses, broad streets with canals and planted with willows. It is an important place for the trade with China, and will be more important after being made a city. Even now large camel caravans pass through Saissan providing the Chinese army with flour; therefore there is more life here than is elsewhere to be found in this region."

THE "CHALLENGER" EXPEDITION

WE publish with pleasure the following additional testimony to the value of the *Challenger* Expedition:—

To the Editor of "Nature."

20, Palmerston Place, Edinburgh, October 2, 1876.

DEAR SIR,—Perhaps you will kindly allow me through your pages to make known to my colleagues of the *Challenger* Expedition the accompanying gratifying resolution passed at the late meeting of the Naturalists and Physicians of Germany.

Believe me, yours very faithfully,

C. WYVILLE THOMSON.

To Sir Wyville Thomson, Professor of Zoology at the University, Edinburgh.

Hamburg, September 21, 1876.

THE forty-ninth meeting of German Naturalists and Physicians, the first which has taken place since the return of the expedition of the *Challenger*, has, in its general session of September 20, unanimously resolved to express its recognition and thanks to the promoters and to the members of this expedition, by which the knowledge of the physical and biological conditions of the ocean has been so greatly extended.

We have the honour to communicate to you this resolution by forwarding the accompanying extract from the Protocol, and pray you to make it known to all concerned.

The Presidents of the Forty-ninth Meeting of German Naturalists and Physicians,

SENATOR KIRCHENPAUER,
DR. DANZEL.

Extract from the Protocol of the Second General Session of the forty-ninth meeting of German Naturalists and Physicians. Hamburg, September 20, 1876.

Prof. Möbius proposed the following motion:—

GENTLEMEN,—I have had frequent occasion to allude to the great expeditions of the *Challenger* and of our *Gazelle*. I could only give you mere indications of what has been so promptly communicated to us by the leaders and scientific explorers of these expeditions, and been thus made the common property of all nations which cultivate science. This assembly of naturalists is the first which has met since the completion of the expedition of the *Gazelle*, commanded by Baron v. Schleinitz, and extending over nearly two years, and since the termination of the expedition of the *Challenger*, under the command of Nares and the scientific directorship of Thomson, after a voyage of three years and a half. I therefore take the liberty of proposing that this assembly express to the promoters and to the members of the expedition of H.M.S. *Challenger* and of H.I.M.S. *Gazelle*, its recognition and thanks for their successful labours in the domain of oceanic exploration.

The motion was then put and passed with acclamation.

I. ARTHUR F. MEYER
Secretary of the forty-ninth Meeting of German Naturalists and Physicians.

NOTES

THE fifth "Exposition des Insectes utiles et des Insectes nuisibles," arranged under the auspices of the Société Centrale d'Apiculture et d'Insectologie, has been held during the last four weeks in the Orangery of the Tuileries, and closed on Sunday. The first exhibition of the kind was held at the Palais de l'Industrie, in 1865, there was a second in 1868, and at the third, in 1872, it was determined to make it bi-annual. The society has three separate committees, one on apiculture, one on sericiculture, and one on general insectology, which sit once a month, and the exhibitions are likewise divided into three corresponding sections. The section devoted to apiculture was much like the bee shows held at the Crystal and Alexandra Palaces, and included a show not only of different breeds of bees, but all appliances employed or suggested as improvements. We naturally have not in England any shows analogous to the section of sericiculture as silkworm rearing is here, only an amusement and not a business. Nor, unfortunately, have we any exhibitions analogous to the section of general insectology, and here it would be well if we learnt a lesson from our French neighbours. The society is endeavouring in various ways to educate the country to a knowledge of the distinction of what insects are useful and what are destructive to crops, granaries, garden-produce, wood, textile fabrics, &c. For this purpose they encourage the formation of collections of insects, each destructive species being accompanied by an illustration of what it preys on. In this respect we are in point of quality still ahead, for the best collection there was not so good as ours at Bethnal Green, made by Mr. Andrew Murray, F.L.S. They were, however, able to show several collections, while we have but one. But besides this they use the elementary schools of the country as a channel for instruction. They offer prizes to these schools for essays and for magnified drawings of insects, the work of the pupils. On one of the tables in the exhibition, a number of the essays were exhibited, and on the walls many of the drawings were shown. The *Morning Post* in speaking of the entomological collection at the Bethnal Green Museum alluded especially to the drawings made by Mr. Andrew Murray, and suggested they should be used as copies in art schools, and that thus the information they teach would be scattered over the country. This same kind of idea is, it seems, already carried out in France. The drawings there, however, are outline pen and ink sketches only, sometimes made from the teacher's copy, sometimes the result of the pupil's own dissections. We have in England a machinery ready at hand for teaching practical entomology, viz., the Science and Art Department. It would not be a very difficult matter to add that to the list of subjects on which teaching is given and examinations are held. Those who know how much the country loses annually by insect ravages would best estimate the value of such teaching that might be turned to practical account.

A LETTER has been received from Capt. Allen Young, of the *Pandora*, who it will be remembered was to endeavour to communicate with or bring back letters from our Arctic Expedition. Capt. Young's letter is dated Upernivik, July 19. He has absolutely nothing to tell of the expedition, as might be expected. He has every reason to believe that the weather in the far north has been favourable to progress. Capt. Young does not state what his next course is, and refers to a previous letter, not received.

OBSERVATIONS have been published by several French provincial papers on the meteor of September 24. One of the most accurate was in the *Echo du Nord*, published at Lille. The apparent diameter of the meteor is stated to have been equal to the moon in opposition; the same measure was given by M. Bamberger, the member for Dunkirk, as reported by that gentleman in a letter to M. Leverrier. The position of the meteor was below Ursa Major, on the eastern side, at 20° from the horizon for Lille. The time in Dunkirk and Lille was the same, 6h. 40m. local time, Dunkirk being a few minutes behind owing to the western longitude. The colour was almost the same, having been described as reddish-blue at Dunkirk and reddish-violet at Lille. A surgeon at Dunkirk said he had heard a hissing sound; a sound was also heard at Lille by a number of people. It was an explosion (*fracas*) according to ear-witnesses, and took place three minutes after the appearance. If correct, that observation shows a distance of about 60 kilometres. M. Leverrier is collecting and examining statements before entering into a calculation. The light was seen by him at the observatory, as reported before the French Academy of Sciences on the following day. It was seen by a number of persons in Paris. The cloud of burning matter and ashes was observed for a considerable time—at least fifteen minutes.

WE are glad to see that means have been taken to obtain subscriptions in aid of the family of the late Mr. George Smith, as a public testimonial of respect to his memory. Contributions to "The George Smith Fund" should be sent to Mr. J. W. Bosanquet, 73, Lombard Street, E.C., in the name of Sir Henry Rawlinson and Dr. Birch.

WE learn from the *Chronique de l'Acclimatation*, that in the just completed New York Aquarium immense basins have been constructed for the reception of the large cetaceans. A number of Otaries have already been received from Behring Strait, and the proprietors hope to be able to exhibit to the public the famous seal Ben Butler, which has for many years frequented the island of San Domingo, in the Bay of San Francisco; the director has offered 5,000 dollars for this curiosity. For the purpose of facilitating scientific researches, the central building contains a library of the best works in natural history, pictures, scientific journals, a laboratory, microscopes, drawing-tables, dissection-room, and all the necessary materials for modelling and photography. Finally, the establishment contains a restaurant in which will be served fish and crustaceans caught before the eyes of the consumer.

PROF. TURNER, of Edinburgh, desires us to correct a misapprehension which appears in our brief notice (NATURE, vol. xiv. p. 485) of his paper on the Placenta, read before Section D of the British Association at Glasgow. He states that the restriction of area in the more complicated forms of placenta

does not diminish but increases the danger of hæmorrhage after parturition. Prof. Turner also wishes us to say in reference to the note on p. 466, as to M. Broca, that that anthropologist in the *Revue d'Anthropologie*, 1876, t. v. No. 2, has given a critical account of Prof. Turner's paper on Cerebral Topography, as also of the writings of MM. Gratiolet, Heftler, and Féré. We may here also state in reference to the report of Prof. W. C. Williamson's paper at the Brit. Ass. (vol. xiv., p. 456), that what Prof. Williamson really said was that the fossiliferous rocks would be the true battle-field on which the problems of evolution would be fought out.

In the *Aftonblad* of the 19th Sept. a letter was published from Dr. Theel (of Nordenskjold's Siberian Expedition), in which he states that, after travelling for ten days by steamer, first on the rivers Tura and Tobol, and then on the Irtisch and the Obi, his party arrived on June 3 at Tomsk, and on the 8th at Krasnojarsk. Starting from the latter town on June 16, they arrived at Jeniseisk on the 18th, and at Turuchansk on July 16, and were at that date hoping to be at Dudinskoj by the 25th of the same month. The party had made rich collections, both zoological and botanical.

The Russian Count Oovarof, is preparing a great work on the "Stone Age in Russia," which will be published in Moscow, with numerous illustrations. Such a work is much wanted, owing to the large accumulation of material during the last few years, and to the absence of any systematic account of them. So far as we know, there have appeared in Russia during recent years, only two monographs devoted to the subject, one by M. Holmberg, on the stone and bronze implements of Finland ("Bidrag till kannedom of Finlands natur och folk," 1858), the other by M. Poliakoff, on the stone age in the Olonetz province ("Mem. R. Geogr. Soc.," 1874).

It is proposed among the physicians and hygienists of St. Petersburg to open there a Hygienic Society, which will be in close connection with the London Sanitary Institute and with the Paris Société Nationale d'Hygiène. Hygiene obtains great attention among Russian physicians, and the fortnightly periodical, *Zdorovie* (*The Health*), has already published, during the first half year of its existence, some very valuable original papers by MM. Arkhanguelsky, Skvortsoff, Shapiro, Gué, Ucke, Hubner, Erisman, Tarkhanoff, Dobroshavin, and others.

The investigation of the upper parts of the atmosphere by means of balloon ascents continues to interest Russian *savants*. Some very valuable additions to our knowledge of the subject have been made during recent years by Prof. Boltzang in Kasan, and by Lieut. Rykatcheff, of the Central Physical Observatory, who took advantage on many occasions of the public ascents of M. Berg. But neither was able to extend their observations to great heights. Now, the Professor of Chemistry of the St. Petersburg University, M. Mendéléeff has devoted to further researches in this direction all the profits which may be received during the next five years from his widely-circulated "Handbook of Chemistry" and other works, as well as the whole profits of a just-published Russian translation, under his editorship, of Prof. Mohn's "Meteorology." It is proposed to construct a large captive balloon, of from two to three thousand cubic metres, and to fill it by apparatus specially devised or modified for the purpose by the Professor.

The last numbers of the *Bulletin* of the Siberian branch of the Geographical Society, published in Irkootsk, contain an elaborate monograph of the fishes of the Baikal, by M. B. Godlefsky.

Preparations are being made in St. Petersburg for the celebration of the hundred and fiftieth anniversary of the Academy of Science, which will be held in the same manner as the fiftieth and hundredth anniversaries in 1776 and 1826. It is rumoured that the Academy purposes largely to increase the number of its honorary and corresponding members, both foreign and Russian, and that a special meeting will be held in honour of the library of the Academy, the first scientific library opened for the public in Russia (October 25, 1728), and which is now one of the richest in Europe in its Natural Science Department, and in the valuable collections of scientific periodicals received from nearly all the scientific societies of Europe and America.

A West Siberian branch of the Russian Geographical Society, receiving a yearly subsidy of 2,000 roubles from the government, will be opened at Omsk. It is hoped that the new section (the sixth section of this large society) will do as much for the extension of our knowledge of the little-known Western Siberia as the East Siberian branch at Irkootsk has done for Eastern Siberia. This last, which enters upon the twenty-sixth year of its existence, has largely contributed to the exploration of nearly every part of its region, from the Polar Sea to the interior of China, and from the Jenissei to Behring Strait, and has published (besides the works which have appeared in the periodicals of the St. Petersburg Geographical Society, of the Imperial Academy, &c.) the well-known Travels of M. Maack, Annual Reports, and a very valuable series of *Memoirs* (eleven vols.) and *Bulletin* (five vols.). We hope that the new section will take more pains to circulate its periodicals than has been the case with her older sisters, the periodicals of the Irkootsk branch being, we are told, almost bibliographical rarities even in St. Petersburg.

The remarkable palæontological and mineralogical collections of the deceased Prof. Folborth, being the result of more than forty years' labours in Russia, are now, according to his bequest, in the possession of the St. Petersburg Academy of Science.

On Wednesday, September 20, an earthquake was felt at Digne, the chief town of Basses Alpes, at seven in the morning. The motion was considerable, although the damage was slight. The last time Digne was visited by a similar phenomenon was in 1873. A destructive one took place on August 14, 1708, and from that time slight disturbances have been comparatively frequent.

A few days since there died in Paris, at the age of sixty-one, M. Joseph Julien, a clockmaker, who had succeeded in directing a small elongated balloon with a screw moved by a spring. The experiment was tried with success in the Hippodrome at Paris, in 1849-50, and attracted much notice. M. Julien died an inmate of St. Anne's Asylum for the Insane.

Mr. John Evans, F.R.S., has just published a *brochure* likely to be of great service to collectors of bronze implements, weapons, and ornaments; it is entitled "Petit Album de l'Age du Bronze de la Grande Bretagne" (London: Longmans and Co.), for the letter-press is in French. This is explained by the fact that the collection was prepared for the meeting of the Prehistoric Congress at Buda-Pest, the official language of which is French. This *brochure* is a mere scintillation from a much larger book which Mr. Evans has been preparing for some years, but which unfortunately does not seem to be near completion. There are twenty-six plates altogether, each with an average of about six figures of various bronze articles, embracing specimens of almost everything in prehistoric bronze that has yet been found. The plates are beautifully executed, and are accompanied by descriptions of all the articles represented.

The death is announced, on September 30, of the Rev. Henry Wilkinson Cookson, D.D., the Master of St. Peter's College, Cambridge.

Mr. W. H. Preece (Memb. Inst. C.E.) is about to proceed to America, under instructions from the Postmaster-General, to

inspect and report upon the technical and scientific arrangements of the telegraphs in the United States. This is one result of the report of Dr. Lyon Playfair's Select Committee.

A BERNE observer has registered the number of days when the shade temperature had exceeded 20° C. in the last twenty-eight years (1849–1876). The number in each of the twenty-eight years is as follows:—31, 19, 22, 27, 22, 11, 17, 29, 30, 26, 47, 10, 37, 16, 34, 20, 30, 24, 31, 56, 31, 56, 31, 44, 38, 26, 40, 55. No regularity whatever is exhibited.

IT is rumoured that the Colorado beetle is amongst us, and unfortunately not confined to the cabinets of collectors.

A BILL is being framed to be brought before Parliament next session for the incorporation of the Andersonian University, Glasgow. The Bill will provide for a change of name and several important modifications in the constitution.

THE progress of education in Russia has in recent years been very marked. In April 1866 the Czar appointed Count Tolstoi Minister of Education. In commemoration of his first ten years of official activity, this minister has recently published a "comparative map of the higher and middle educational institutions of the ministry of education in the years 1866 and 1876." The facts expressed by the map are given in tabular form, in a recent number of the *Russische Revue*, and the following extract will show, in general form, the increase in number of higher and middle educational institutions during the decennium in question:—

	1866	1876
Universities and other higher institutions ...	8	18
Gymnasia ...	101	133
Pro-gymnasia ...	7	69
Real-schulen and Real-gymnasia ...	11	53
Technical institutions ...	—	11
Seminaries for teachers ...	9	60
Girls' gymnasia and schools of first rank ...	39	66
Girls' pro-gymnasia and schools of second rank	55	148
	222	540

UNDER the title "L'Erborista Toscano," the eminent professor of botany at Pisa, Prof. Caruel, publishes an analytical key to the natural orders, genera, and species of Phanerogams and Vascular Cryptogams (or, as he terms them, Prothallogams) found wild in Tuscany.

UNDER the title "Contributions to the Flora of Iowa," Mr. J. C. Arthur prints a list of the flowering plants of the State, 979 in number, including varieties and introduced species, with critical notes on some of the species.

WE have before us the *Bulletins* of the Torrey Botanical Club of New York, Nos. 17–20 of vol. vi. They comprise a list of the Musci and Hepaticæ of Colorado collected by T. L. Brandegee in 1873–75, and determined by E. A. Rau; notes on some rare southern plants, by H. W. Ravenel; and several minor papers, chiefly of local interest.

WE have a useful contribution to botanical biography in a sketch by Prof. E. Morren, "Mathias de l'Obel (Lobelius), sa vie, et ses œuvres, 1538–1616."

THE additions to the Zoological Society's Gardens during the past week include five Perch (*Perca fluviatilis*) from British Fresh Waters, presented by Master B. L. Sclater; a Rüppell's Spur-winged Goose (*Plectropterus rüppelli*) from East Africa, a Grey Struthidea (*Struthidea cinerea*) from Australia, two Chinese Jay Thrushes (*Garrulax chinensis*) from China, deposited; four American Darters (*Plotus anhinga*), two Boatbills (*Cancroma cochlearia*), a Sun Bittern (*Eurypyga helias*), two Black-faced Ibises (*Geronticus melanopis*), a Stilt Plover (*Himantopus nigricollis*), two Bahama Ducks (*Pœcillonetta bahamensis*), a Red-billed Tree Duck (*Dendrocygna autumnalis*) from S. America, a Slaty-headed Parrakeet (*Palæornis schisticeps*) from India, purchased.

SCIENTIFIC SERIALS

THE recent numbers of the *Journal of Botany*, Nos. 161–165 (now edited solely by Dr. H. Trimen), contain no one article of very special interest; but several interesting contributions to foreign and British botany of a more or less technical character, and strongly illustrating the present tendency of British botanists to devote themselves to systematic and nomenclatorial, to the almost entire exclusion of morphological and physiological work. —Dr. R. Spruce describes a new genus of Hepaticæ, and the Rev. M. J. Berkeley two new genera of Fungi, under the names respectively of *Anomoclada*, *Kalchbrennera*, and *Macowania;* and the Rev. J. M. Crombie some new Lichens from Rodriguez. —Mr. Hemsley and Dr. Hance add to our stock of information on the botanical products of China and Cambodia.—Dr. M. T. Masters identifies the pear recently discovered in Britain and described under the name of *Pyrus communis* var. *Briggsii* with the well-known continental *P. cordata* of Desvaux.—Mr. J. G. Baker continues his useful work on the hitherto little-studied Irideæ, his contributions in the present number including the Ixieæ and the genera *Aristea* and *Sisyrinchium*, with descriptions of a new *Xiphion* and *Crocus* from the Cilician Taurus.—There are many minor notes of much interest.

THE *Nuovo Giornale Botanicò Italiano*, edited by Prof. Caruel, has increased its number of pages in each part; but, with its increase in quantity, has suffered no deterioration in quality. Indeed, the Italian botanical journal is now among the most important of European serial publications in botany. In the two numbers before us, the second and third for the present year, the articles of interest are so numerous that we can only glance at some of the most important, at the risk of doing scant justice to the remainder. The longest article is one which extends over the two numbers, on the alimentation of cellular plants, by G. Cugini. The result evidently of great labour and research, it is impossible even to give an abstract of the conclusions at which the writer arrives. With regard to the relative importance of the various elementary substances of which the food of plants is composed, he differs somewhat from the results arrived at by Sachs and detailed in his "Text-book," especially in considering potassium, calcium, magnesium, and iron as of nearly equal value in the vegetable economy. He thinks that potassium has a somewhat similar relationship to the carbohydrates to that which phosphorus bears to albuminoids. Signor Cugini's list of the essential food-materials of plants comprises organic carbonaceous substances, water, ammoniacal salts, sulphates of potassium and iron, phosphate of magnesium, and an alkaline silicate; and that of non-essential ingredients, in the order of their importance, the chloride, iodide, or bromide of sodium or potassium, the phosphate, nitrate, or sulphate of calcium, and salts of zinc, manganese, and aluminium.—Prof. Delpino contributes a paper on dichogamy and homogamy in plants, which is of great interest in view of Mr. Darwin's promised work on cross-fertilisation and self-fertilisation. After classifying plants into homogamic and dichogamic, he further subdivides the former class into homoclinic, in which the pollen fertilises the ovules in the same individual hermaphrodite flower; homocephalic, in which it fertilises ovules in flowers belonging to the same inflorescence; and monœcious, in which fertilisation is effected on ovules contained in flowers on a totally different part of the same individual. A series of experiments indicated that the fecundity resulting from pollination was in an inverse order to that given above.—Dr. G. Gibelli has made a careful examination of the infolded leaves of *Empetrum nigrum*, a common plant on our mountain heaths, and finds a striking resemblance, on a miniature scale, to the pitchers of *Nepenthes*, *Sarracenia*, &c., suggesting also an analogy of function. The paper is illustrated by two well-executed plates.—Cryptogamic botany comes in for its full share of attention.—In addition to papers On the Bacteria parasitic on fungi, by Dr. Lauzi, On the structure of *Pilularia globulifera* and *Salvinia natans*, by G. Arcangeli, and On *Isoëtes Duriæi*, by A. Piccone, there are others on the fungi of Venetia, on the Hepaticæ of Borneo, on new Italian fungi, and on the mosses of Liguria.

Der Naturforscher, April—July.—In the numbers we note an account, by M. Hoffmann, of a singular phenomenon in an orchard near the village of Heuchelheim. A large fire occurred in the village in the beginning of September, and four weeks after it numerous trees in the orchard (pears and damsons, *e.g.*) that had been singed by the fire began to vegetate anew, putting forth tender green leaves and blossoms, often by the side of fruits

which the fire had spared. Examining the wood with a microscope he found the starch contents of the cells transformed into a pulpy mass; sugar was present both in the singed and the unsinged trees. M. Hoffmann tried to reproduce the above phenomenon artificially, but failed, doubtless through not hitting the right temperature.—In another botanical paper M. Pringsheim maintains that the red in Florideæ is a modification of the green in these plants, and not an immediate modification of the chlorophyll of phanerogams.—There is an instructive abstract in the May number of M. Suess' recent work on the origin of the Alps. He considers the members of the Alpine chain to have been formed not through a pressure from below upwards, in the middle, but by a horizontal force acting towards the north or north-east and capable of being deflected by obstacles in its superficial action. In North America and in great part from the Pacific Ocean to the Caspian the same direction of force appears; but further east, *e.g.*, in the Red Sea and Indian Valley the direction is different; in the highlands of Central Asia the prevailing movement is towards the south and south-west. M. Suess specifies various forms of mountain-formation.—We note an interesting lecture by M. Jager on the significance of gill-slits in taking of food. They permit rapid escape of the water sucked in (but not of the morsel) and in a backward direction, not interfering with advance of the fish. In fish that chase their prey the gills open widely. In flowing water fishes have in general wider gill-slits than in still. Gill-less amphibia get their food mostly in the air or on the surface. Tritons take food under water awkwardly as compared with fishes, and they prefer large bites that the outflow of the water may be facilitated.—In a paper on conceptions of the arrangement of atoms, M. t'Hoff denotes as an "unsymmetrical carbon-atom" one which is combined with four different elements or radicals. He affirms that every compound containing such an atom must be able to exist in at least two isomeric modifications. Further, the optical activity of an organic substance is caused by the presence of an unsymmetrical carbon atom.—We find in the June number a brief account of Dr. Bessel's observations on the intensity of heat radiation from the sun in high latitudes. This, it appears, increases with the altitude of the pole.—M. Sanson has been making observations on the excretion of carbonic acid in the larger domestic animals. Genus and species have influence on the respiration; thus, Equidæ excrete more CO_2 than Bovidæ. Males excrete more than females; young animals more than old. Food, so long as it maintains the normal state, has no influence on the breathing functions, nor muscular exertion when ended. The excretion of CO_2 is directly proportional to rise of atmospheric temperature, and is inversely as the barometric pressure—these two influences compensate each other.—It is shown by M. Gassend that plants lose in weight under coloured glass.—From experimenting on the phenomena of affinity in slow oxidation of hydrogen and carbonic oxide through platinum, M. v. Meyer concludes that carbonic oxide is much more strongly attracted by the platinum molecules than hydrogen, and forms an envelope round these, hindering access of the hydrogen molecules to the platinum, and only permitting it when a great part of the carbonic oxide is oxidised.—July.—Some observations by M. Serpieri lead him to an explanation of the zodiacal light as an electrical aurora.—The passage of electricity through gases forms the subject of an investigation by M. Oberbeck.

Journal de Physique, May—August.—In studying the propagation of heat in crystalline and schistous bodies, M. Jannettaz has improved on Senarmont's method by applying to the (larded) surface a small sphere or truncated cone of platinum, which is heated by means of a battery current. In minerals the heat is propagated less easily in the direction perpendicular to a plane of cleavage than parallely to this plane; in matters of schistous texture less easily in the normal direction than in directions parallel to the laminæ, both cases being included under the general rule that heat is propagated most easily between the surfaces that have most cohesion together. Planes of stratification (unlike planes of schistosity,) have no influence on the position of the axes of the curves of fusion. M. Jannettaz describes the plan by which he finds the orientation of the axes of the thermal ellipses relatively to certain guiding lines; he utilises the doubling of the curve by means of a birefringent prism.—M. Mannheim points out some new optical properties deduced from a geometrical study of the surface of the wave, and M. Mouton describes a rapid means of determining the interior resistance of a battery.—A new manometer for measurement of high pressures is described by M. Cailletet; it is based on the observed fact that a cylindrical glass reservoir is diminished in volume proportionally to the pressure on it, up to a point near that of rupture, and that this deformation is not permanent. Such a cylinder, with spherical calottes and a capillary tube, is filled with coloured liquid and screwed by means of a copper adjutage into the top of a strong steel cylinder in which the pressure is to be produced, the capillary tube projecting. The pressure sends the liquid up in the latter.—M. Marey describes an apparatus for showing the velocity of a ship at any instant, and which is an improvement on the methods of Pitot and Darcy. Two vertical tubes have their lower ends bent at right angles; the orifice of the one is turned forwards, that of the other backwards (in the water). The tubes are continued upwards and enter two capsules (like those of aneroids) placed opposite each other. The inner opposed faces of these are connected by a bar toothed on its upper edge, which catches in the toothed wheel of a dial pointer. Two caoutchouc tubes above connect the capsules with a T tube, by which water is first sucked up so as to fill the apparatus. The variations of pressure produced by the ship's motion are now revealed on the dial through expansion and contraction of the capsules. The advantage of the method is that no change in depth of immersion through pitching, &c., affects the position of the pointer, but any change in the ship's velocity is at once indicated.—It is shown by M. Mercadier that the duration of the period of a tuning-fork depends on the amplitude and the temperature, and that, using the instrument as chronograph or interrupter, identical results at different times will only be had if the temperature and the amplitude be the same. If, as is usual, complete identity and large amplitudes be not required, then, so long as an amplitude of 3 mm. to 4 mm. is not exceeded, and the temperatures are little different, one is certain of having the same number of periods per second to nearly 0·0001.—M. Gernez writes on determination of the temperature of solidification of liquids, particularly of sulphur; M. Duboscq describes, with figures, his improved apparatus for projection of bodies placed horizontally (*e.g.*, the magnetic curves) and his transparent projection-galvanometer; and M. Lippmann gives a *résumé* of theories of the radiometer.—M. Terquem having sought some alcohol varnish which would cover glass with an almost invisible layer, on which one might write or draw, recommends one composed of alcohol 100 cubic centimetres, mastic 7, sandarach 3.—M. Becquerel gives an account of his experimental researches on rotatory magnetic polarisation (which he has described to the Paris Academy).—M. Jannettaz has observed that in the process of piercing a crystal normally to the plane of symmetry, the air interposed between the deformed and the traversed lamina gives rise to elliptical coloured rings similar to ellipses of conductivity, and he has investigated the value of the coefficients of elasticity according to the radii vectors of those curves. He determined the coefficients of elasticity of flexure of gypsum plates in different direction, especially those parallel to the axes of the ellipses. Comparing their relations with those of the axes of conductivity, he found the former to be represented by the cubes of the second (the numbers being 1·939 and 1·247).

Archives des Sciences Physiques et Naturelles, April–August.—These numbers contain several useful papers. There is a review of Swiss geology for 1875.—The origin of the *Tchernozem*, or black earth covering the upper parts of the southern plain of Russia, from the Carpathian to the Oural, has been much discussed. M. Bogdanow finds in his researches on the subject, that the deposit consists, and continues to be formed, of the remains of vegetation both of steppes and of forests; its thickness, colour, and composition vary with the subsoil; the thickest layers are 1·8 m (Murchison said 6 m.), and indicate that the region has long since emerged. The Tchernozem has been met with in other countries, Transylvania, Moravia, North America, &c. M. Bogdanow traces the history of the plains of Russia and of their fauna.—M. Demole studies the action of bromine on ethylenic chlorhydrine, and a new simplification of the fundamental electro-dynamic law, viewed in relation to the principle of conservation of energy, is furnished in a note by M. Clausius.—In reply to the question: Has the age of a tree influence on the mean epoch of its foliation? M. de Candolle states that in only some few species, as the vine, the foliation is retarded by age. Young trees are often earlier than those of twenty, thirty, or forty years of the same species; but this may be due to nearness to the ground, or to other local circumstances, independent of age. Similar reasons will account for buds in the

upper part of a tree opening later than those below; and in any case the influence of age on foliation is nil, or small, compared with the influences of climate.—M. Ebray contributes a paper on the impossibility of establishing the limits of geological formations, and discusses some other geological principles.—The July number is mainly occupied with a *coup d'œil* over the principal publications on vegetable physiology in 1875, by M. Micheli.—M. Wiedemann communicates two short notes on the specific heat of gases, and on the changes of the co-efficients of friction of gases with the temperature.—M. Hagenbach, in the August number, studies the equilibrium of a sphere on a jet of water. There are two cases of the phenomena. In one of these, the jet, divided into drops, strikes the sphere laterally at about 50° from the lowest point, and makes it turn rapidly about a horizontal axis. The sphere also often moves round the jet, sometimes in one direction, sometimes in the other. The water follows the sphere in its movement, flies off in a series of tangents, some of it, however, returning to the point of initial impact. The other case is that in which the sphere receives a homogeneous jet at the same point, and does not rotate about it, but passes to-and-fro across the jet between the two corresponding positions. It turns about the horizontal axis, now in one direction, now in the other. M. Hagenbach gives an explanation of these results.—M. Schmankewitsch replies to some criticism of his researches on the changes of *Artemia salina* in water of varying saltness.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, September 18.—Vice-Admiral Paris in the chair.—The following papers were read:—Examination of observations presented at various epochs regarding the transit of an intra-mercurial planet over the disc of the sun, by M. Leverrier. He cites eleven of these, comprised between 1761 and 1820 (the paper to be continued).—Theorems relating to systems of three segments having a constant product, by M. Chasles.—Note on the period of the exponential e^z, by M. Yvon Villarceau.—Lighting by means of products extracted from resinous trees, by M. Guillemare. Distillation of oil of turpentine resting on an equal volume of slightly alkaline water, removal of it by steam, and direct and prolonged action of concentrated solutions of alkaline carbonates on oils of resin, produces complete separation of the colophony and naphthaline these liquids contain; this effect is proved if ammonia no longer affects their limpidity. To utilise the large percentage of carbon for light, two lamelliform currents are arranged round the wick; the exterior, by means of a cone 8 centimetres in height, the other, interior, with a movable conical nipple. The draught is effected with a glass chimney, which has to be ground at the base, so intense is the light. This light is recommended for ships' lanterns and photo-telegraphic apparatus.—On a mode of treatment of phylloxerised vines with lime, by M. Pignede.—M. Lucan presented an instrument employed by the negroes in Congo for capturing serpents. This is a tube, the walls of which are made of pieces of reed interlaced; when the serpent enters they contract through the very efforts which he makes to escape.—On the capture of rattlesnakes, and the supposed association of these serpents with a small owl and a small dormouse, by M. Trécul. Travelling, in 1848, in the region west of Arkansas, he caught snakes by passing over them, when erect, a loop with running knot attached to his ramrod; they remained quite straight and were easily killed. The "villages of little dogs," or dormice, are sometimes pretty large, *e.g.*, half a kilometre in diameter. One was in a fertile district covered with high herbs, but the ground of the village was entirely denuded by the animals, and little earthworks thrown up, with holes in them, and communicating together. The dormouse takes a survey from the top of these eminences, with only his head thrust out. In coming out, which they do most cautiously, they give a small sharp bark. In another village the author saw a little owl issue from one of the burrows, which was also evidently frequented by dormice; and in another burrow was a rattlesnake, but this burrow had evidently been long deserted by the other animals.—Symbolic formula giving the degree of the position of points, the distances of which from given algebraic curves verify a given relation, by M. Fouret.—On the physical properties of gallium, by M. Lecoq de Boisbaudran. This subject is noted elsewhere in connection with the *Journal de Physique*. We here note that the density the author formerly obtained (4·7 at 15°) was different from that to which M. Mendeleef's theoretical views pointed (5·9), for a body between indium and aluminium to which gallium otherwise closely corresponded. Having lately, however, treated some gallium by keeping it half an hour at 60°–70° in nitric acid, diluted with its volume of water, washed, heated strongly, then solidified it in dry air, he obtained the number 5·956, which agrees with that of M. Mendeleef.—Anatomical and morphological researches on the nervous system of hymenopterous insects, by M. Brandt. He studies the metamorphoses which occur in the ganglionic chain in passage from the larval to the adult state.—Experiments and observations on vitreous rocks, by M. Meunier. He concludes (1) That vitreous rocks do not represent the product of a vitrification of crystalline rocks, but the latter are derived from the former by way of devitrification. (2) The direct devitrification of obsidian, gallinace, retinite, &c., cannot be produced, and the presence of gases and vapours in the vitreous rocks seems to be the opposing obstacle. (3) This devitrification becomes possible when the rocks, by fusion, are freed from their volatile elements.

Rome

R. Accademia dei Lincei, June 4.—On the specific rotatory power of asparagine, by M. Cossa. He extended the researches of Pasteur on this subject, varying the proportion of asparagine to the solvent and experimenting with other acid solutions. He refers the specific rotatory power (which, for most of the liquids experimented with, might be considered as a constant) to the yellow rays of the spectrum.—On the rotatory power of santonic, metasantonic, and hydrosantonic acid in various solvents, by M. Cannizzaro.—On the electrical state of bodies, by M. Volpicelli. The electricity manifested in bodies through the condenser is to be attributed to the electricity of the atmosphere, since it follows in quantity and quality the phases of that.—M. Volpicelli replied to memoir of M. Pisati, entitled "Defence of the Old Theory of Electrostatic Induction;" also to a note by M. Cantoni on a pretended reform of the theory of electrostatic induction: also to a letter of Maxwell's in Nature (vol. xiv. p. 27).—Studies on microscopic images of medullary nerve-fibres, by M. Boll. He studies the alterations produced by a variety of chemical agents—sodic chloride, osmic acid, glycerine, ether, chloroform, &c. He finds that the myaline does not form a continuous sheath within the axis cylinder. The medullary sheath is composed of a series of segments placed one above another (in the sciatic nerve of a frog he counted twenty to twenty-five of these segments).—Duration of vitality of the *macula germinativa*, by M. Colasanti. Experimenting with hen's eggs, he found that in the first twenty days after the egg is deposited, development of a chicken may take place, but after that epoch development is not the rule but the exception. But the germinal spots which did not produce chickens always showed some development, though incomplete. This shows that the evolution is not the result of a force which exists or does not exist in a germ, but rather of a force subjected to quantitative modification, and which expires gradually.

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THURSDAY, OCTOBER 12, 1876

OUR NATURAL HISTORY COLLECTIONS

THOSE who pass along Cromwell Road, South Kensington, will not fail to observe on the site of the former International Exhibition, a stately building rising from the ground under the superintending genius of Mr. Waterhouse. The contractors have labelled it "The Museum of Natural History," but when the building is completed (which will be the case in November, 1877, according to the Office of Works) it may "surprise" our readers to be told that there will be no "Natural History" to put into it. The Natural History Collections in the British Museum—which are commonly supposed to be national property—belong not to the people of England nor to the "Government," but to fifty "Trustees" who are obliged by statute to keep them in Great Russell Street, and nowhere else. In order to enable these collections to be removed to South Kensington when the new building is ready to receive them, it will be necessary to pass an Act of Parliament discharging the Trustees from their present statutory duties and enacting others applicable to the new site. Now the Royal Commissioners on Science, who have recently terminated their labours, have devoted a good deal of time and attention to this branch of their subject. They have come to the conclusion that the removal of the Natural History Collections to another building will be a good opportunity for effecting a radical change in their administration, which, as it is now conducted, is by no means satisfactory either to men of science or to the public. It must be recollected that the British Museum was originally instituted as a great public library, to which the collections of art and science were considered merely as appendages. The director of the whole institution is still called the "Principal Librarian," and even up to a recent period the whole of the staff, even in the scientific departments, was classified under the fiction that they were "assistants" in the Library. The consequence of this leading idea is that everything in the British Museum, even up to the present time, is sacrificed to the extension and glorification of a single department. The Natural History Collections have, it is true, a nominal head, and a very eminent person he is, but Prof. Owen has nothing to do with the government of the institution, and has not even access to the trustees when they meet in solemn conclave. All he can do, when anything is wanted or something goes wrong in one of the Natural History Departments, is to approach the trustees through the principal librarian, an excellent individual, no doubt, but a gentleman entirely unacquainted with natural science and its requirements. It will be easily imagined, therefore, that under this system everything is sacrificed to the Library. The head-executive officer, naturally enough, thinks that his own branch of the business is of by far the greatest importance, and that everything else should knock under to it. As an illustration of this fact we have only to turn to the Civil Service Estimates for the current year. It will be found that 10,000*l.* is to be spent upon the purchase of printed books for the British Museum although copies of all those published in the United Kingdom are obtained gratis, whereas the miserable pittance of 1,200*l.* is allowed for zoological specimens, 800*l.* for fossils, and 400*l.* for botany! It may be alleged by the trustees that these amounts are sufficient, but the contrary is notoriously the case. The general level of the zoological and botanical collections in the British Museum is undoubtedly far below what it ought to be. The finest specimens in nearly every department of natural history fall into the hands of amateurs because the National Collection is so badly supplied with funds for purchases of this kind. No dealer would think of offering a new butterfly or a new humming-bird to the British Museum. With the former he would go to Mr. Hewitson with the latter to Mr. Gould. Again, the staff of officers in the Natural History Departments is inadequate in point of numbers. Their salaries likewise are much below those of other branches of the Civil Service, and quite insufficient for the duties expected of them. Hence it follows that there is little temptation for young men of ability and education to accept such a career. These deficiencies might have been remedied long ago if the trustees had been content to give up their patronage. But the right of presentation to all places in the British Museum is vested by statute in the three principal trustees, and the Government, naturally enough, declines to increase the value of appointments over which they have no sort of control.

Under these circumstances it is not to be wondered at that the Royal Commissioners on Science have come to the conclusion that, as regards the Natural History Departments shortly to be removed to South Kensington, the irresponsible rule of the fifty trustees should altogether cease, and a more simple form of government come into existence on the new site. Nothing can be more successful than the National Botanical establishment at Kew, governed by a Director immediately responsible to one of the Ministers. The Science Commissioners, with good reason, recommend a similar form of administration for the National Zoological Museum at South Kensington.

In this view, as will be seen by reference to their report, the Commissioners are supported by the best men of science of the day, many of whom have emphatically condemned the present system. One short clause in the Bill which must be brought in to authorise the transfer of the Natural History Collections to South Kensington will be sufficient to discharge the trustees from all future responsibility connected with them, and we trust there will be no hesitation on the part of her Majesty's Government in following the excellent advice tendered to them by the Science Commissioners on this subject.

CENTRAL AFRICA

Naked Truths of Naked People: an Account of Expeditions to the Lake Victoria N'yanza and the Makraka Niam-Niam, West of the Bahr-el-Abiad (White Nile). By Col. C. Chaillé Long, of the Egyptian Staff. (London: Sampson Low and Co., 1876.)

THIS work is more than usually interesting, as the author was an American officer in the Egyptian army attached to the expedition of Col. Gordon, the successor

of Sir Samuel Baker. The descriptions of the country and the various tribes who are the "Naked People" of the title, lead us for the most part over ground that has been already brought to our notice by Speke, Baker, and Schweinfurth, but a peculiar charm is contained in this volume, as it introduces to our notice some of the *Dramatis Personæ* of "Ismailia," and we find ourselves in the presence of many of the principal characters pourtrayed in the last work of Sir S. Baker; among others, the now well-known slave merchant, Abou Saood.

Some persons may not have forgotten that Sir Samuel Baker was accused of having dealt somewhat too harshly with this arch slave-trader, and it is therefore gratifying to receive the testimony of Col. Long who in p. 20 writes on arrival at Khartoum:—

"It may not be foreign to the subject to allude here to the unfavourable impression produced upon government officials and the well-wishers of the expedition on learning that Abou Saood was on his way to join us, that he had been renominated, and would go to Gondokoro in connection with the administration of the Equatorial Provinces; for in Khartoum Abou Saood was looked upon as inimical to the interests of the Government in these regions. Reference to him will be hereafter made and his true connection with the expedition and final fate be fully shown."

On March 22, 1874, after an extremely rapid journey of only twenty days from Suez, Col. Long, in company with Col. Gordon, left Khartoum by steamer for Gondokoro. The terrible difficulties which had impeded the expedition of Sir Samuel Baker had vanished, and the great White Nile was opened to navigation by the removal of the enormous vegetable obstructions. This great work had been accomplished by the energy of Ismail Ayoub Pacha, the governor of Khartoum, who, by the special orders of the Khedive, suggested by Sir S. Baker, had worked with a large force during two following seasons (not for only three weeks as supposed by Col. Long), and the river had resumed its original character. The fleet of seven steamers which Sir S. Baker had sent up from Alexandria to Khartoum had now an uninterrupted channel, and communication between Khartoum and Gondokoro would be effected in twenty days, instead of the weary and pestilential voyage of twelve months, so painfully described in "Ismailia." Under these favourable conditions Col. Long reached Gondokoro on April 17, and he immediately prepared to visit the interior instead of delaying at that unhealthy station.

The Commandant, Raouf Bey, furnished him with two trustworthy soldiers from the faithful "forty thieves" of Sir S. Baker. These men, Saïd Bagāra and Abd-el-Rahman, proved themselves worthy of the high reputation of the corps, by extreme courage and devotion throughout their service with Col. Long. In company with a large party of irregular troops, Col. Long started from Gondokoro to the Victoria N'yanza, on April 23. The company included a personage who becomes famous in the course of the narrative; this is Ba Beker, of whom Col. Long thus writes:—"The presence at Gondokoro of a wily black named Ba Beker, who had made his way through Unyoro, coming from M'tésé, King of Uganda, and bearing letters to Sir Samuel Baker from Lieut. Cameron, announcing the death of Livingstone, at Ujiji, seemed a propitious circumstance"—p. 36.

It is to be regretted that Col. Long appears to have been ignorant of the previous history of certain characters which appear in his narrative. The "wily black," Ba Beker, was formerly the dragoman, or interpreter, belonging to Abou Saood's station at Fabbo, and he had learnt the language of Uganda during a visit to the court of M'tésé. Ba Beker's character for cunning and intrigue was so well known to M'tésé, that, when that potentate formed an alliance with Sir S. Baker, he stipulated that Ba Beker should not be sent to his court as he was untrustworthy and a dangerous schemer. Sir S. Baker therefore sent from Fatiko a soldier named Selim, who had formerly been one of the "faithfuls" with Speke and Grant, and knew the language of Uganda. This man Selim was one of the "forty thieves," and he accompanied the envoys of M'tésé to remain at his court as a representative of the alliance formed with the Egyptian Government. The grand reception which Col. Long received from King M'tésé upon his arrival at his capital, was the satisfactory result of the friendship established with the king by Sir Samuel Baker, who at his instance had already sent two expeditions in search of Livingstone, one of which had reached Lieut. Cameron, and had returned from an enormous distance, bearing letters for Sir Samuel Baker; these were sent down from Uganda to Gondokoro, by the wily Ba Beker, who had, against orders, found his way to the court of M'tésé. Ba Beker will be remarked throughout the narrative as a plotter against the success of Col. Long, whom he attempts to infect with small-pox, by sending a native reeking with that disease to march by his side.

Col. Long commenced his journey during the rainy season, and his people suffered severely from fever and the miseries inseparable from a wet march. At that time the new territory was occupied by several important military stations left by Sir Samuel Baker, including the Fort Fatiko on 3° lat., and Foweera, on 2°, in the country of Unyoro. The latter station had been formed when Sir S. Baker established an indissoluble alliance with Rionga after the attack by Kabba Réga at Masindi, which terminated in the defeat of the natives and the total destruction of their capital; but as the country was bare of provisions, the troops were forced to destroy their own camp, and to join Rionga.

Col. Long started under the favourable conditions that M'tésé, on the equator, was an ally of the Government; Rionga had been declared chief of Unyoro by Sir S. Baker. Two powerful government stations existed along the road; several stations, such as Fabbo and Faloro, were held by the irregular troops established by Sir S. Baker (formerly slave hunters) under the command of Wat-el-Mek, and no enemies were supposed to exist except Kabba Réga, who had apparently somewhat recovered his position after the departure of Sir S. Baker to England.

In speaking of the Baris, the first tribe through which he passed, Col. Long says (p. 47):—"The treacherous and cowardly Bari had at length accepted as a fact the definitive occupation of the country by the government troops, against whom, these people, and in fact every other tribe, had been excited by the Dongolowe faction."

(The Dongolowes are the slave and ivory hunters.) This is important evidence, which coincides with the description of Central African politics in "Ismailia."

On April 28 Col. Long arrived at Moogi, the last of the Bari tribes. As the Bari refused to sell provisions it became necessary to forage. This is the great difficulty of that portion of Africa, the troops must either starve or help themselves; in the latter case it is not surprising that the natives offer resistance, which ends in bloodshed. Three of Col. Long's people were killed by the Moogi, and a general attack commenced. A rapid and skilful disposition of his force enabled Col. Long to disperse his assailants, and charging them at the double, they were put to flight. This was his first experience of the docile negro, who, we are told by philanthropists, is to be gained by conciliation. Col. Long's "Naked Truths" appear to take a more practical and common-sense view of the African savage. On April 30 Col. Long has another skirmish with the Moogites, and it should be remembered that this tribe had never opposed Sir Samuel Baker's march and were treated most kindly by him. The return for this consideration was an attack upon Col. Long, and the subsequent massacre of the unfortunate Linant de Bellefonds, with thirty-six of the gallant "forty thieves" sent to make a reconnaissance by Col. Gordon.

On May 5 Col. Long arrived at Fatiko, near 3° latitude. He thus describes it:—

"Fatiko is a neat little earthwork surrounded by a fosse about ten feet deep, constructed by Sir Samuel Baker, flanked on its western side by a huge rock mountain that serves as well for a look-out. Its position and construction render it almost impregnable, certainly against any African force. From its rocky eminence one might see the Nile, though more than a day's march distant, winding its serpent-like way from the Albert N'yanza."

Speaking of the officer, Adjutant-Major Abdullah, whom Sir Samuel Baker had left in command, Col. Long writes:—"It gives me no little pleasure to refer here to the cleanliness and discipline of his command, and the *esprit de corps* which he had instilled into both officers and men." This is a gratifying result from the labours of a European who first planted these stations in Central Africa to suppress the slave-trade.

At Fatiko Col. Long was introduced to Wat-el-Mek, who commanded the irregulars. This man, conspicuous in "Ismailia" as the chief agent of Abou Saood, who was subsequently pardoned by Sir S. Baker and appointed to his present command, determined to escort Col. Long to Foweera, and together with Selim, already described, and the wily Ba Beker, they started, May 12, towards Foweera, about seventy miles distant. On May 17 they reached the camp, garrisoned by 270 men, and described by Col. Long as a "model of neatness and order." After a rest of some days at the station of Foweera, during which Col. Long was much impressed with the noble appearance and character of Rionga (the chief with whom Sir S. Baker had formed an alliance by exchanging blood), he at length started for the capital of M'tésé in company with Selim (Sir S. Baker's representative) and the wily Ba Beker, who was extremely jealous of the co-interpreter. After a terrible journey of rain, slush, and numerous deep marshes, which induced distressing attacks of fever, Col. Long and his party arrived at the capital of the great King M'tésé.

It is absolutely necessary to refer all readers of African travels to the work itself, as "Naked Truths" will yield a rich harvest of horrors, which would intrude too largely upon the space accorded to a review. The reception given by the great King M'tésé commenced by the cold-blooded massacre of thirty people in Col. Long's presence! This is the monarch whose praises Mr. Stanley sings! It is indeed necessary that "Naked Truths" should be impressed upon the public. Col. Long's description of M'tésé is perfectly truthful, agreeing with that given by Capt. Speke. There can be no doubt that in spite of his savage customs he is far more enlightened than most African monarchs, and much can be done with his assistance in opening Central Africa to commerce. We can only hope that his country will not be annexed to Egypt, in which case we should lose the confidence of a man who has already rendered most important assistance as an independent potentate. If the simple traveller shall be known in Africa as the forerunner of an invading army, and the return for a gracious reception shall be the loss of a kingdom, future explorers will be regarded in Central Africa with well-merited suspicion, and the ordinary dangers of the country will be enhanced.

Col. Long visits a small portion of the Victoria Lake, which conveys an impression since proved to be erroneous. He then proceeds in two canoes with his faithful Saïd Bagāra and Abd-el-Rahman, together with a few followers, down the river from Urondogani to Rionga's Island. He is dreadfully ill, and the wretchedness and misery he describes will show that nothing has been overstrained in the accounts of those regions previously published. When opposite M'rooli, lat. 1° 38', where the Nile is more than a thousand yards wide, he is attacked by a fleet of forty canoes by the people of Kabba Réga. The fight which ensued is one of the liveliest scenes of the book, and the cool and accurate shooting of Col. Long and his two ex-"forty thieves," with Snider rifles and a large supply of ammunition, win the day, and save the little party from destruction.

In a state of great physical prostration from hunger and continual sickness, our gallant explorer and his little party reached the military station at Foweera (Rionga's). At this place he made an important discovery, that on the same day that he was attacked by Kabba Réga's fleet of canoes at M'rooli, Sulieman, the ex-slave-hunter, but present officer of the Egyptian Government, was actually residing with Kabba Réga at his palace! Col. Long needed no further proof of treachery; it was a repetition of the conduct pursued towards Sir S. Baker, and as Col. Long writes "in acting against me, he was but proving his hostility to the Egyptian Government and his sympathy with Kabba Réga, the old ally of Abou Saood." In fact, the irregulars formed of the disbanded slave-hunters of Abou Saood knew that their occupation was gone, and they still clung to the hope that some fortuitous circumstance might lead to the withdrawal of the Government from the new territory, and the return of the good old times of slavery.

Col. Long had hoped to visit the Albert N'yanza, but

finding it quite impossible, he at length returned to Fatiko. His final report of the Fatiko natives is as follows:—

"The Fatiki of all the negro tribes I had seen are the most moral and the most honest. They were very numerous, and their well-filled corn-bins attested their frugality and their industry in the cultivation of 'dourah,' the sole product of the soil."

It will be remembered by readers of "Ismailia" that Sir S. Baker delivered these good people from the yoke of Abou Saood's slave-hunters, and they have ever since shown their gratitude by cultivating corn sufficient for the support of the garrison. In p. 205 Col. Long writes:—

"The garrison of Fatiko, composed of 200 men, was sheltered from any attack not alone from its position in a military point of view, but because of the entire sympathy of the natives, who were most friendly to the government troops and acknowledged their authority with pride at being considered as belonging to 'Meri.'" . . .

Nothing can be more satisfactory to the true well-wisher of the negro than such a picture, neither could any more convincing proof be desired of the grand reform effected in these districts by the Khedive's expeditions to suppress the slave trade.

On October 18 Col. Long returned to Gondokoro, where he heard with sorrow that most of the Europeans had died during his absence. He speaks with honest pride of the congratulations that he received from the Governor-General (Col. Gordon) upon the results of his arduous journey. He was also visited by Abou Saood, of whom he writes:—

"Abou Saood came to see me and to welcome me back. From the very great dignity with which he had been invested on his arrival, he had now fallen into disgrace."

Col. Long now returned by steamer to Khartoum to recruit his health by change of air, and having remained at the Soudan capital for sufficient time, he once more returned to the White Nile regions with reinforcements. On his voyage to Lado, a new station which Col. Gordon had established fourteen miles north of Gondokoro, he was tempted to explore the important river Saubat, which is the largest affluent of the White Nile. In a powerful steamer he passed up the stream of the Saubat for about 300 miles, and arrived at an ivory station of the Arabs far beyond the highest point reached by Europeans. The Saubat was reported navigable for an unknown distance, but circumstances compelled his return, and Col. Long, after a rapid passage, once more joined Col. Gordon at Lado.

A short rest at this station prepared him for an expedition into the Niam-Niam, or cannibal countries west of the Nile. During this journey Col. Long lost a considerable number of men from sickness, and, as usual, was attacked by the natives, who succeeded in killing one of his soldiers. With the assistance of the irregular troops from the Niam-Niam stations, and those warlike tribes of cannibals, he defeated the enemy, and his allies ate them as refreshment after the battle. Col. Long subsequently returned to Lado, and after a short but brilliant career in Central Africa he returned to Egypt, to take the command of an expedition sent by the Khedive to the Juba river on the east coast of Africa.

In concluding a notice of this volume we must express a regret that Col. Long gives us no astronomical observations; therefore no practical addition has been made to our geographical knowledge. There are also some instances of careless description, as he speaks of "deer," whereas no species of deer exist, and he must mean "antelopes." He tells us of a boa constrictor 30 feet long, with a thickness equal to the body of a child. This is a careless picture of an enormous snake that deserved to be accurately measured as a curiosity in natural history.

There are no pretensions to literary style in this book, but the charm exists in the evident truthfulness and absence of prejudice which pervade it throughout. Col. Long is far too honest and straightforward to condescend to stratagem to win the applause of the public; he does not believe in the good qualities commonly attributed to the negro.

The impression left on the mind after carefully reading Col. Long's "Naked Truths," is that such men as he undoubtedly is, are the true stamp for the improvement of Central Africa—a character which combines courage, energy, love of liberty, and fair play, and sound common sense with patience, must effect good, and such a man will always be respected by the negro equally with more enlightened races.

OUR BOOK SHELF

Electro-Telegraphy. By Frederick S. Beechy, Telegraph Engineer. (E. and F. N. Spon, 1876.)

WHY Mr. Beechy should wish to depart from ordinary usage and call his book electro-telegraphy rather than electric telegraphy, we have no idea. The assumption of an eccentric title for a scientific book naturally gives rise to a feeling of prejudice against it. Nevertheless, we find in this little book a very fair and clear account of the practical part of electric telegraphy. It would be impossible, in 125 pages, to deal fully with this great subject. Mr. Beechy has, however, managed to compress into that short space an account of the principles and methods both of sea and land telegraphy, sufficient to give an intelligent reader a very good notion of how telegraphy is carried on. He has wisely avoided all detail regarding telegraph instruments. In his diagrams he generally gives a skeleton illustrating a principle without attempting to display details that would only complicate the figure. His descriptions are generally clear and simple.

It is surprising, however, that he has not taken the trouble to explain the elementary principles of electric science more thoroughly. We are far from satisfied with the preliminary chapters on this part of the subject, and we have noticed some very extraordinary mistakes. In the chapter devoted to "testing" we read as follows: "The *metre*, or French standard of length, is a certain sub-multiple of the diameter of the earth. The standard of time, or the second, is derived from observation of the earth's revolution. The standard measures, such as the yard measure or the pound weight, may be lost or destroyed, and the only security for always obtaining reliable standards is the permanence of the great natural laws of our globe." This is very astonishing. To say nothing about the "diameter," which may be a misprint, we thought that though the writings of Balfour Stewart, Maxwell, Thomson, and the celebrated B.A. Unit Committee, every one knew better than to trust to permanence of the earth's dimensions for replacing the metre were it lost.

The next paragraph defines the Ohm. "The *Ohm* is obtained by observing what effect is produced by a current of electricity on a certain conductor in a given time. As a certain metal rod represents the yard, so a wire of a

certain resistance represents the *Ohm*. The *Ohm* is a small coil of German silver wire representing the resistance overcome by a current in a certain time." What kind of conception can Mr. Beechy have of current and of resistance?

Still, as we have already said, we are much pleased with Mr. Beechy's little book. The author can readily make the necessary improvements in a future edition.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Action of Light on Ebonite

It is well known to electricians that the insulating power of ebonite gradually diminishes in consequence of the formation of a conducting layer of sulphuric acid on the surface (produced by the oxidation of the sulphur used in vulcanising). It is perhaps not so well known that exposure to light facilitates this change, if indeed it is not an essential condition.

In order to put this to the test, a plate of ebonite polished on both sides was cut into four pieces, each about 52 mm. long, 22 mm. wide, and 8·5 mm. thick, exposing therefore a surface of about 3,500 square millimetres (the edges were not polished), and one half of each piece was varnished with an alcoholic solution of shellac. Two pieces were placed in wide test tubes plugged with cotton wool, and the other two were sealed hermetically in similar tubes. One of the sealed tubes and one plugged with cotton wool were placed in a dark drawer, and the other pair exposed to light in the laboratory, and during the latter part of the experiment to direct sunlight. The experiment was commenced on December 26, 1874, and after some time minute drops of liquid were perceived on the ebonite exposed to light and air, the remaining three pieces retaining their original appearance. Between September 1 and 21 of this year the sealed tube exposed to light was accidentally broken, so that for a period of less than three weeks the ebonite in it was exposed to both light and air. On September 21 the tubes were opened, the ebonite washed with water, and the amount of acid determined by standard solution of caustic soda. No trace of acid could be detected on either of the pieces of ebonite which had been kept in the dark; on the one which had been exposed to light in the closed tube, ·343 milligrammes of sulphuric acid were found, and on that exposed to light and air, 2·646 milligrammes.

By a mistake it was not ascertained whether the part of the ebonite which had been varnished had become acid, but during the time of exposure small drops were also perceptible on this portion of the surface. When the pieces were exposed to direct sunlight another change became visible, the drops being replaced by what appeared to be small particles of a yellowish white solid. This may have been due to the heating of the black material by the sun and consequent action of the strong acid on the solid.

I was led to try this experiment by noticing that an ebonite plate electric machine which had been kept in a light room had changed in colour except on those portions which had been protected from light by the rubbers. The exposed surface acquired a brown colour and the machine acted very badly. On cleaning the plate with a hot solution of caustic soda, large quantities of ammonia were evolved and the brown surface became softened, so that it could be easily scraped off.

I had an opportunity of noticing a remarkable instance of this action a short time since in the laboratory of my friend, Mr. Warren De la Rue. An apparatus with an ebonite base, with three adjusting screws, was standing at some distance from a window. The surface of the plate was covered with a fine dew of an acid liquid, except at the parts where the shadows of the heads of the screws fell. The surface at these places completely retained its original polish.

The interest of this matter must be my excuse for communicating the results of an incomplete experiment.

Royal Indian Engineering College, Cooper's Hill, October 2 — HERBERT McLEOD

Visual Phenomena

The following quotation was written, and a stereo-slide to which it was appended was sketched by myself in January last, and shown at the *soirée* of the Manchester Mechanical and Scientific Society then held:—

"In looking through comparative darkness at any bright light, the writer, who is near-sighted, sees in place of such light or any number of such lights, a bright disc or discs each like the stereoscopic combination of the figures here shown.

"Are such figures seen by other myopic subjects, and do they consist of the middle portions of the crystalline lenses as seen *from within*?

"In order to develop the figures the source of light must be sufficiently distant to subtend an angle of about one-twelfth of a degree; the discs have an apparent diameter of about 1° or more, being like the pupils which seem to define their outline, persistently variable in size (*i.e.*, always *on the move*). The disc-patterns are constant in markings and position, and their brighter lines irradiate the darkness (of the vitreous humour) as though by refraction from the (?) denser portions of the lens."

The discs above mentioned differ a little in each eye, but the groundwork in both cases is a somewhat irregularly five-armed star; each arm has a shaded axis with bright margins, and they radiate from a luminous ring inclosing a darker central spot. The whole figure is well illuminated, its details being defined rather by variations of light than by dark markings, and their comparative brightness *inter se* being not unlike that shown by the various parts of the lunar surface at the full. The intervals or *sectors* of the figures are filled with a mottled pattern not easy to sketch; one space contains a figure like a Y with the stem outwards; another a V point inwards. Some dark spots, inside bright rings, as they are exposed or excluded by the margin of the figure, curiously define the varying size of the pupil as one approaches or recedes from the light; at about 12 yards from (say) a street lamp the disc is suddenly supplanted by the true form of the gas flame.

I see these appearances with the unassisted eyes; a concave lens at once snuffs them out. About sixteen years ago I tried some experiments with *convex* lenses, and found that on holding the lens farther from the eye than its (the lens's) focal distance, the star figure suddenly became a NEGATIVE—its cardinal points reversed, its lights shadows, and *vice versâ*; the arms bright, with shaded borders, and the dark spots bright, with shaded rings.

On coming from darkness into a gas-lighted street, the star discs appear large for about a second, then suddenly contract, but retain a slight oscillation, corresponding with the slight but incessant movements of the iris. The conjunction of lightning and street-lamps has a curious effect; *after* each flash the hundred or more of discs, one at each light, suddenly contract and more leisurely expand, the contraction taking about one second and the readjustment about four.

In place of Mr. Mallock's Fig. 2 (p. 350), I get a sort of very acute St. Andrew's cross, its arms consisting of *parallel* rays crossed by numberless very fine striations.

Fig. 3 I only see as a tangled confusion, owing to the hairs not being so neatly arranged as in Fig. 4; yet their foreshortened crookedness seems, by way of amends, to be responsible for the following:—

In looking towards, but a little below, the sun, which should be at about its winter meridian altitude, the upper field of view is crossed by a sort of variegated aurora of rainbow colours, which have almost a polariscope brightness, and are lined and ringed, as it were, upon a sort of chain pattern foundation.

It was in November or December last that I first found that the before-named star figures were not necessarily extinguished by a light sufficiently strong to allow of my sketching them; the occasion being a highly successful Manchester copy of a London fog. A lucid interval and a lowered gas-jet in a large room accidentally gave the requisite conditions.

If considered of sufficient interest, I would send copies of the discs which are sketched nearly two inches in diameter. The disc of a gas-lamp at 100 yards distance has an apparent diameter of nearly 3 feet, and a lighted up cotton-mill is all light, no wall. — H. B. BIDEN

Sale, Manchester

If Mr. T. W. Backhouse (NATURE, vol. xiv., p. 474) is right in interpreting the phenomenon of radiance described by Mr. A.

Mallock, as due (in Mr. Mallock's case) to *under*-refraction of rays (as in my case it certainly is due to *over*-refraction), his own experience furnishes a good connecting-link between the "two different, though allied, phenomena." It would be well, however, in order to avoid all uncertainty, that we should know the result, in Mr. Mallock's case, of experiments with an obstacle advanced in front of the eye from a given direction. The experiment with concave or convex spectacles is not quite satisfactory, because it involves a breach of continuity in the observation of the phenomenon.

In concluding that I am "evidently short-sighted," Mr. Backhouse attributes to the whole lens a fault which really belongs only to certain radial portions of the marginal region of the lens. In daylight I see distant objects sharply defined, and that without excessive contraction of the pupil. It is at night, when the pupil is largely dilated and the *marginal* part of the lens becomes exposed to incident rays, that I see radiance around a distant lamp.

These phenomena being necessarily personal to each observer, not admitting of observation by one person for another, and evidently presenting wide differences, it would be interesting to collect and tabulate the facts as described by a number of competent observers. I would suggest that the initiator of this correspondence (Mr. A. Mallock), or some other person, with the approval of the editor of NATURE, should receive and tabulate such facts as may be communicated on this subject, with a view to the publication of the results in a future number of NATURE. HUBERT AIRY

Blackheath, October 3

An Intra-Mercurial Planet

IF the phenomenon seen by the Hon. F. A. R. Russell was really a transit of this planet, Hofrath Schwabe must have very narrowly escaped witnessing it, for on turning to his MSS. I found the following observation for the date in question :—

"1860, Jan. 29, 9m. (8.11 A.M., G.M.T.).

"Nur die Hauptflecken von 10 deutlich dem Austritte nahe, 11 undeutlich, 12 u. 13 nicht wesentlich verandert."

The numbers refer to the drawing of sun-spots made on the preceding day, indicating also the order in which the spots have appeared since the commencement of the year. No. 10 is a group of spots near the limb, No. 11 a group of very small spots also close to the limb, whilst 12 and 13 are clusters of large spots both of sufficient magnitude to be visible to the naked eye through a fog.

Unfortunately the Photoheliograph was not at work on that day, nor did Carrington make any observations, the sky being cloudy. G. M. WHIPPLE

Kew Observatory, October 7

Inequality of the Semi-Diurnal Oscillations of Barometric Pressure

WILL you oblige me by publishing the following corrections of certain of the formulæ in my paper on the Inequality of the Semi-Diurnal Oscillations of Barometric Pressure, in NATURE, vol. xiv. p. 316? I regret that the distance of my place of residence has prevented my sending you an earlier notice of the errors.

Formula (2) should stand thus—

$$\text{“}\tau = V\rho \frac{P}{\mathsf{P}} \frac{T_\circ}{T} lc,$$

"wherein ρ is the density of air at standard pressure P and temperature $T_\circ$, &c."

The same symbol P should be substituted for P in the next formula, and the explanation should run—

"where s is the hypothetical density of water vapour at P and $T_\circ$, and λ its latent heat at temperature T. Substituting for s its appr6ximate equivalent $\frac{5}{8}\rho$,

$$\tau = V \tfrac{5}{8} \rho \frac{p'}{\mathsf{P}} \frac{T_\circ}{T} \lambda.\text{”}$$

HENRY F. BLANFORD

Meteorological Office, Calcutta, September 5

Miniature Physical Geology

THE occurrence of miniature earth-pillars (vol. xiv. p. 423) is by no means unusual even in our own country.

I noticed some excellent examples some years ago in the neighbourhood of Halifax. From a steep exposure of alternating strata of sandstone and shales, the sandstone stood out in broad ledges which received on their upper surface the *débris* from the weathering shale, consisting of mud and plate-like fragments of the shale itself. Under the action of the rain this *débris* had been carved out into perfect pillars, each capped with its plate of shale, and with a numerous progeny of smaller pillars clustering round it, each also with its protecting roof of jutting shale.

Near the Mumbles (Swansea) I visited a limestone quarry at the foot of which lay a talus of soft earth embedding a number of fragments of limestone. Here not only were large earth-pillars from two to four inches high, and in every detail of form resembling those of the Tyrol, to be seen sculptured from the talus, but a heavy shower of rain falling at the time was actually at work producing fresh columns and enlarging the old ones. I had with me at the time, by good fortune, a party of some forty students, and was pleased beyond measure to be able to point out to them these beautiful pillars and the process of their growth. So perfect were they that one gentleman more enterprising than the rest wished to transport one fine group to the safe keeping of a glass case.

But the most striking examples of earth-pillars I have seen anywhere occur in this neighbourhood. The trias, which here frequently consists of a breccia of hard sub-angular fragments of various kinds of rocks embedded in a red sandy marl, is in many localities cut through by the roads, and thus exposed in almost vertical faces of considerable length on the side of the roadway. These faces have very generally been carved out into earth-pillars, which, whilst resembling in all else the Botzen pillars, differ from them in remaining attached vertically to the parent rock by one face, and thus are free on three sides only. This ornamentation of the rock-faces in high relief may be seen continuously for many yards, I should think for hundreds, and it is permanent from year to year. No one walking from Dawlish to Little Haldon can fail to be struck with its singular appearance, and it is especially well exhibited on the right hand bank of the road skirting the north-east side of Luscombe grounds. The ordinary earth-pillars, free on all sides, may also be occasionally noticed in great perfection. After last year's heavy rains I saw several measuring 3 inches high and 2 inches broad at the summit: in one case the capping was not of stone, but a piece of growing moss, which had become detached from a mossy bank by a landslip on a small scale. W. J. SOLLAS

Dawlish, Devons

The Claywater and Meno Meteorites

THE analyses of these remarkable bodies by Dr. J. Lawrence Smith, as given in the *American Journal of Science* for September, 1876, suggest a new and interesting inquiry in astro-meteorology. These analyses gave the following results: –

	Claywater.	Meno.
Stony matter	78·33	77·76
Metallic particles	17·07	18·00
Troilite	4 60	4·24
	100·00	100·00
Stony part, soluble	47·20	48·70
Stony part, insoluble	52 80	51·30
	100·00	100·00
Stony part, analysed as a whole		
Silica	44·98	44·70
Protoxide of iron and aluminia ...	21·95	22·26
Magnesia...	29 30	28·97
Lime	1·80	1·85
Soda	1·32	1·20
	99·35	98·98
Metallic particles		
Iron	92·15	91·86
Nickel	7·37	7·53
Cobalt	·28	·13
Copper and phosphorus...	Traces of both.	
Specific gravity	3·66	3·65

"In regarding the above comparative statement of the composition of these meteorites," says Dr. Smith, "it will be seen that the compositions of the two as made out by me do not

differ more than those of two fragments of the same meteorite, while they both differ in their *physical aspects* from the ordinary type of meteorites, and, in fact, they have few or no parallels in the collections of these bodies."

Are the above coincidences to be regarded as accidental, or do they indicate an original connection between the two bodies? The former alternative is seen at once to be almost infinitely improbable. But the Meno stone fell in Mecklenburg at noon, October 1, 1861, and the Claywater meteorite, in Wisconsin, at 9 A.M., March 25, 1865, the interval being nearly three years and a half. How, then, could the bodies have been originally connected? It will be observed that the two points of orbital intersection are almost diametrically opposite, and may therefore be regarded as the ascending and descending nodes of the same meteoric group. The possibility of an original intimate connection of the two meteorites becomes thus sufficiently obvious. The nodal points correspond approximately to those of the comet of 1264.

It may here be remarked that a similarity of composition was also found in the aërolites of May 22, 1827, and June 2, 1843, both analysed by Baumhauer. DANIEL KIRKWOOD

Bloomington, Indiana, U.S.A., September 5

Comatula rosacea

IN NATURE, vol. viii., p. 469, is a report of an excursion by the Birmingham Natural History and Microscopical Society to Teignmouth, and of the results of its dredging operations in that neighbourhood, in which the following passage occurs:— "By far the most noteworthy capture was *Comatula rosacea*, the Feather-star, two individuals of which were taken in the larval pedunculate condition attached near the base of a frond of Laminaria, which was torn off by the dredge. The specimen measured about one-third of an inch in length. Five young Comatulas in a free condition, the largest about an inch across, were also taken. A subsequent haul on the following day brought up from the same locality three adults." A foot-note states that this was in the vicinity of Torbay, at a depth of 12 fathoms, on a limestone bottom.

It may perhaps be interesting to the above Society, and to the readers of NATURE generally, to know that during the last month Mr. Hunt and myself, in his handy little sailing-vessel, dredging in Torbay, have taken Comatulæ, not by twos and threes, but in the greatest abundance. In one haul off Berry Head there were certainly more than a hundred adults. On this occasion the dredge was brought on board cramfull of the commoner genus, *Ophiocoma rosula*, of which there must have been many thousands, the Comatulas forming only a small percentage. This haul was in about 12 fathoms, on a very rocky bottom. We met with pretty similar results close to the Thatched Rock. It is evident that the habitat of Comatula is strictly defined, viz., in comparatively deep water and amongst rocks. We have never taken a single specimen from sandy or shelly bottoms.

On examining the few pieces of sea-weed and zoophytes brought up at the same time, they were found to be covered with the young stalked state of the Feather-stars, which were principally attached to *Bugula flabellata* and *Salicornaria farciminoides*. As I write, I have before me a small bottle of spirit and water, in which is a little spray of the latter zoophyte about 2 inches in height, and to which are attached at least seventy specimens in every stage of growth, from the calcareous bud, with its zoophyte-like tentacles, to the perfect, but stalked, form of the Feather-star, with its five bifurcated arms; and on a single microscopical glass side and cell I have mounted as many as a dozen specimens, all growing on the same small piece of weed.

It is generally stated that both Comatula and Ophiocoma, on leaving their native element, break themselves into pieces. My experience does not bear this out. It is true that, as they crawled about the deck in their own peculiar fashion, the Ophiocoma especially left an occasional arm behind, but as a rule I could take either of them up in the palm of my hand without their exhibiting any suicidal propensities. Presuming on this fact, I put about a hundred of the two sorts into a sponge bag, but this was asking too much of them, for on reaching home and emptying them out, I found that both Feather-stars and Brittle-stars had converted themselves into a mass of mincemeat! It would have been difficult to find a single portion of an arm a quarter of an inch long.

The microscopic study of the structure of the various genera and their organs of locomotion is most interesting, but is beyond the scope of this communication, which is merely intended to show that *Comatula rosacea* and its young stalked state is not so uncommon as is generally supposed, but can be obtained in considerable numbers, especially if one is so fortunate as to have as a companion such an experienced dredger as my friend, Mr. Hunt. FRED. H. LANG

Influence of Islands on Colour of Animals

THE September number of *Blackwood's Magazine* contains a narrative by Mrs. Frances Wordsworth and her son, Mr. C. F. Wordsworth, of six months and twenty-two days spent by the survivors of the unfortunate *Strathmore* upon one of the rocks of the Twelve Apostles, an island in the Crozet group.

If I venture to draw attention to the following extracts from their story, it is because they seem to illustrate in a rather remarkable manner some observations upon the influence of islands in determining paleness of colour in animals, which occur in Mr. A. R. Wallace's opening address to the Biological Section of the British Association at Glasgow.

The *Strathmore* was wrecked on July 1, 1875, and speaking of a period four months later, when penguin's eggs had begun to furnish the castaways with ample food, Mr. Wordsworth says: "The eggs did everyone a great deal of good; those who had been haggard and miserable got quite plump and fresh; some of them ate about thirty at a meal, and we now saw each other with clean faces, for we used the eggs as soap; while a most remarkable thing was that every one had fair skins and light hair, dark faces and hair being quite changed, black hair turning brown or red, and fairer people quite flaxen. As for myself my complexion was pink and white, like a girl's" (this after four months' constant exposure to the weather) "with white eyebrows, yellow hair and moustache."

The survivors were rescued on Jan. 21, 1876, and on Feb. 18, Mrs. Wordsworth writes, "Charlie looks well and firm now; his hair had got quite flaxen, which did not suit him at all, but now it has nearly recovered its original colour."

With regard to animal life on the rock, Mr. Wordsworth says: "I had almost forgotten to mention the real owners of the soil. The only unwebbed footed birds on the island, and constant residents, were what we called 'little white thieves,' 'white pigeons,' or 'white crows.' They possessed many of the qualities of our jackdaw, being very inquisitive, mischievous, and hardy, and not to be daunted by trifles." D. PIDGEON

Holmwood, Putney Hill, September 27

ARE WE DRYING UP?

SUCH is the title of a paper in the September number of the *American Naturalist*, by Prof. J. D. Whitney, the object of which is to bring together some of the more striking facts in regard to the desiccation of the earth's surface—or at least of a considerable portion of it—which has taken place in the most recent geological period, and to suggest the inquiry whether we have any proof that this desiccation has been and is continued into the historical period: in short, Are we drying up?

There is a prevailing popular impression that the countries around the Mediterranean are drier than they were two or three thousand years ago, and that this change is due in part, if not wholly, to the cutting down of the forests which are assumed to have once existed there. Yet, when this matter comes to be investigated, it would appear that there is little if any evidence either that there has been any such wholesale stripping of the wooded lands, or that there has been any considerable change in the climate of that region. It appears to be true, at all events, that exact observations with the rain-gauge have not yet anywhere been kept up for a sufficient time to enable us to speak with certainty with regard to the existence of any secular change in the amount of rain falling at any one place.

We have, however, abundant evidence of a great change over at least a considerable part of the earth's surface in the amount of water distributed in the lakes or running in the rivers, and it can be shown, beyond a doubt, that this change has been taking place within a very recent period, speaking geologically. Some important evidence can also be adduced to the effect that this change has been continued in the historical epoch,

although not yet capable of demonstration by the recorded observations of the rain-gauge.

There are two regions especially where the facts already collected show most clearly not only a diminution in the amount of water existing on the surface, but a most striking one. In Central Asia and in Western North America, the observations of numerous observers all point unmistakably in this direction. The observations of the Schlagintweits in Thibet and Turkistan are referred to. In all portions of High Asia, south and north of the main water-shed, in Thibet, throughout the entire longitudinal depression between the chain of the Himalaya and the main water-shed of the Karakorum, there are numerous places where the former existence of mountain lakes may be recognised In Western Thibet the evaporation exceeds the supply of water, so that the prevailing condition is at the present time one of gradual diminution in the area covered by water. There seems to be here, in combining all the results of the Messrs. Schlagintweits' observations, abundant evidence of a marked change of climate in the most recent geological period—resulting in the almost entire disappearance of extensive lakes—and also that this desiccation is still going on.

The observations of Mr. Drew in his elaborate work on the Jummoo and Kashmir territories, fully corroborates the often previously expressed opinion, that the Valley of Kashmir was, in later geological times, completely occupied by a lake. But no evidence has, as yet, been discovered to prove that this desiccation took place during the historical period, although the traditions of the natives point in that direction. There is, however, abundant proof of diminution in the area covered by water in the basin of the Aral and Caspian Seas, not only during the latest geological epoch, but also within a comparatively recent period. Those who wish to investigate the matter will find the material in a paper by Major Wood, published in the *Journal* of the Royal Geographical Society for 1875, and we may state in his recent work on "The Shores of Lake Aral," and in the articles contributed by him to NATURE. There is no doubt of the former vastly greater extension of the Caspian and Aral Seas; it seems beyond dispute that a gradual desiccation of the region has been in progress, and that it is still going on. That there once existed here a vast Asiatic Mediterranean which was connected by navigable waters with the Northern Ocean is very generally admitted.

Similar facts in regard to the diminished quantity of water in Arabia are cited by various travellers in that country. In Africa the existence of extensive ruins in the Great Libyan Desert, in a region quite destitute of water, and which is now entirely uninhabited, may be taken as a strong indication of great changes since the historic period. Dr. Livingstone, in his travels in Southern Central Africa, was again and again much impressed with the proofs presented to him of a rapid and extensive diminution within recent times of the amount of water in the lakes and rivers of that region.

Prof. Whitney adduces much evidence to show that a similar state of things exists in America, especially in the region west of the Rocky Mountains, and above all in the "Great Basin." For example, the terraces surrounding Great Salt Lake are so conspicuous, that no traveller passing through that region on the railroad could fail to notice them. It is certain that the sharp and well-defined character of the terraces in some parts of the western region indicates very clearly that the diminution of the volume of the water must have been an extremely recent phenomenon. It is doubtful whether this desiccation has any connection with the former glaciation of the regions in question; so far as the problem under discussion is concerned, it is of no consequence.

It is certain that both in Asia and North America the phenomena of desiccation are on too grand a scale by far to be supposed to have anything to do with cutting down of forests. The drying up has been commenced before man interfered with nature, and has been continued without reference to his puny operations.

Evidence is adduced to prove that within the historical period, the volume of several of the European rivers has considerably decreased. In this connection the investigations of Berghaus on the Rhine, the Elbe, and the Oder are referred to. Berghaus shows that each of these rivers had decreased in volume during the past hundred years, and that there was reason to fear that they would eventually have to disappear from the list of the navigable streams of Germany. Gustav Wex came to the same conclusion with regard to the Danube.

The general impression, both of Mr. Wex and a committee of the Vienna Academy, seems to be that the cutting down of the forests is the essential cause of the desiccation. But the number of facts which can be given in support of this hypothesis is quite small. That a positive diminution in the average quantity of water carried down in the streams would necessarily ensue on removing a portion of the forests in any region, Prof. Whitney does not consider to have been proved as yet.

In regard to one question, this commission of the Vienna Academy is quite unanimous, and this is that great pains should be taken by the different Governments of the enlightened States throughout the world to obtain more light and additional data bearing on this subject. If desirable for Europe, Prof. Whitney thinks it is still more so in America. They need much more numerous and more accurate observations of rainfall. If it can be shown that the removal of the forests seriously diminishes the quantity of water running in the streams, then there is yet time to stay the hand of the wood-cutter ere the mischief be consummated.

That there has been a very marked decrease in the amount of water on the earth within the most recent geological period is beyond a doubt; and that there is considerable reason to believe that the desiccation is still going on has, we think with Prof. Whitney, been made evident by the facts he adduces. He promises on another occasion to discuss the connection of the so-called "glacial epoch" with the present one of desiccation.

The subject is one of great interest and of prime importance, both from a scientific and an economical point of view. The New York *Nation*, in referring to Prof. Whitney's paper, tries to account for the phenomenon as follows:—

Setting speculative causes aside, such as the possible variation in the central heat beneath the earth's crust, there is one well-known cause which, we think, can scarcely be demonstrated to be incapable of producing the desiccation. The sun's heat is notoriously the source of all climates, and changes in the amount of heat radiated from the sun are now regarded as causing the changes in terrestrial weather. It is therefore reasonable to ascribe our drying-up, since it requires ages for its completion, to a change in the solar cause requiring also a long cycle for its fulfilment, provided that astronomy gives us proof of any such change. And astronomy does tell us of two such cycles: one in the obliquity of the ecliptic, and one in the perihelion distance of the earth from the sun, both cycles being results of planetary perturbations of the earth's orbit. The effect of the second of these cycles is too abstruse to explain here; the first is simpler. As the angle between the plane of the earth's equator and that of her orbit diminishes, the limits of the torrid zone also diminish, inasmuch as that zone is bounded by the tropics which are determined by the angle in question. The region, then, over which the sun is occasionally vertical is being narrowed. An obvious result of this narrowing would seem to be an intensification of the equatorial phenomena of trade-winds, heat, and rainfall within the torrid zone, and a corresponding loss of heat and of precipitation in the extra-tropical zones.

PRINCIPLES OF TIME-MEASURING APPARATUS[1]

I.

WE cannot measure time in that sense in which we measure other things. Time has been very happily defined as the great independent variable of all change; and it is by watching matter in motion, which is the simplest form of change with which we are acquainted, that we estimate its progress. Thus, the motion of the earth around its axis furnishes us with that well-defined interval, the day; and the motion of pendulums (which swing against the earth's attraction) and of watch balances (which swing against the attraction of the particles of matter of which their springs are composed) furnish us with its subdivisions. I mention this at starting, because during our discussion, I want you perpetually to bear in mind that pendulums and watch balances are not mere appendages or terminations to the mechanism of time-measuring apparatus, but are themselves the true time-measurers; and in general, the question of accurately constructing such apparatus resolves itself into the problem of obtaining an uniform impulse—just such an impulse, neither more nor less, which shall exactly restore to the pendulum or watch balance that amount of motion, of which it has, during its preceding swing, been deprived, by the friction of its connections, and the resistance of the atmosphere.

Our natural time-measures, the sidereal and solar days, are determined respectively by the passage of a star or the sun across the plane of the meridian. The solar day is three minutes fifty-six seconds longer than the sidereal day, the reason of which will be obvious from the accompanying diagram (see Fig. 1). During the

FIG. 1.

time of rotation, the earth, E, has advanced a little distance upon its annual journey round the sun, S. Therefore, any place upon its surface will have to proceed just a little further (through the angular space $S_1 E_2 S$) in order to get the sun opposite to it, than it would have had to have done, had the earth been stationary. The sidereal day is practically the time of one exact rotation of the earth upon its axis; the distance of the stars being so indefinitely great, that their rays throughout the width of the earth's orbit may be considered to continue parallel.

The measure employed in our ordinary every-day reckoning of time is mean solar time, which we derive in this way. Through sundry astronomical causes, the time of the earth's rotation with respect to the sun is not exactly uniform, solar days differing at certain periods of the year by as much as half an hour. In order to avoid the practical inconvenience which it would occasion by having days, hours, and minutes of different lengths, at different seasons, we add the time of all the days of the year together, and dividing by their number (which is fractional) we obtain the average length or mean of the days, and we refer to this and its sub-divisions as days, hours, minutes, of mean time.

Hour-glasses, candles, and water-glasses, were the instruments used by the ancients to indicate the passage of time. It was not till a comparatively recent date that apparatus consisting of a moving body, impelled through the medium of a combination of wheels (which also served to register the body's progress) was introduced for the purpose. We have a very good illustration of such early mechanism in the clock from Dover Castle (see Fig. 2).

A rope supporting at its extremity a weight, W, is wrapped around a cylinder or barrel, B, and by its means

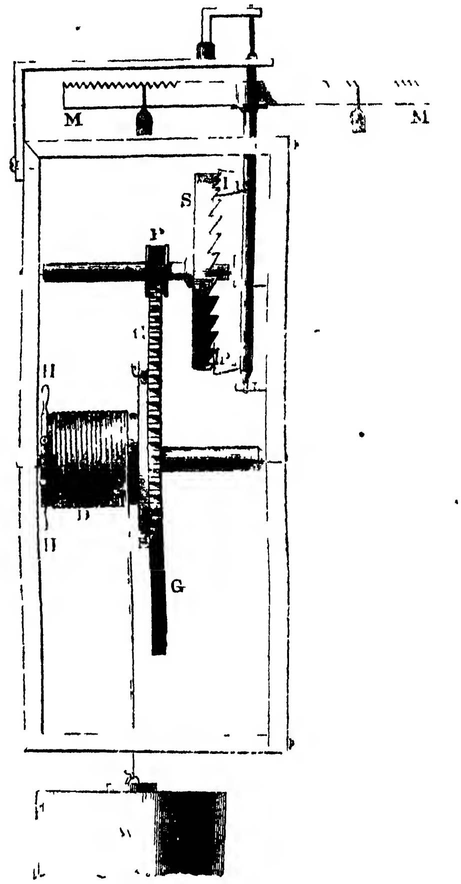

FIG. 2.

drives the wheel G G. This wheel is engaged with a pinion, P, and through it impels the escape-wheel S. The teeth of the escape-wheel operate upon two tongues or pallets, P_1 P_2, set at an angle to each other upon the stem carrying the moving body or time-measurer, M M. The

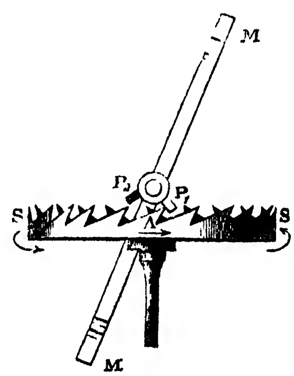

FIG. 3.

action of the wheel upon the pallets is exceedingly simple; the tooth A (see Fig. 3[1]) is now pushing the pallet P_1 to the right. It will presently have pushed it out of the way

[1] Lecture by Mr. H. Dent Gardner, a the Loan Collection, South Kensington.

[1] For comparison with Fig. 2, imagine the wheel to be moving in the reverse direction, and the letters P_1 P_2 interchanged.

altogether, and then the tooth beyond upon the opposite side of the wheel will fall upon the other pallet, and a process similar will take place. By this arrangement the moving body, or balance, will alternately be driven backwards and forwards.

Prior to experiment, it is not easy to see why a contrivance such as this is should not go (in other words run down) with uniformity. We have a constant weight impelling a constant weight, and the contrivance itself destroys acceleration, but the fact is, we here overlook the great disturbance due to friction.

If we could indefinitely magnify each of the surfaces now in contact in this machine, we should see that what we call sliding and rubbing is (especially upon the pallets) in reality tearing and grinding, and the wonder would be, not that the motion produced is not equal and regular, but that it should have any tendency whatever in this direction.

No doubt the first steps towards equalising the motion

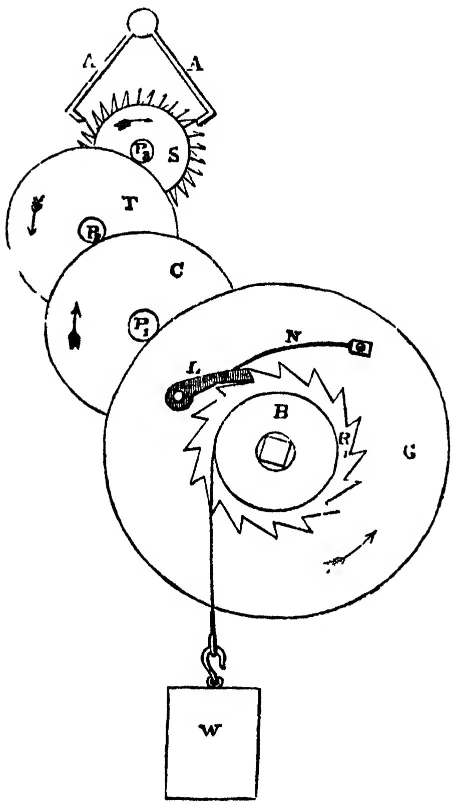

Fig 4

of such apparatus were in the direction of a general improvement in their workmanship and mechanical arrangement. Then came the fundamental ones of the pendulum for clocks and the pendulum spring for watches, and lastly, those in the arrangement of that mechanism (called the escapement) which modifies the manner in which the power of the clock weight is finally administered to the pendulum or balance.

It will be convenient to discuss these improvements not strictly in historical sequence; we shall begin with the machinery itself, or clock-train.

Trains.

Fig. 4 shows the general arrangement of a modern clock-train. G is the "great wheel" connected with the "barrel" B, around which the line carrying the weight W is wrapped. This great wheel drives a pinion, P_1, fastened upon the spindle of the centre-wheel C, and the centre-wheel in turn drives another pinion, fastened to the spindle of the third wheel T, and the third wheel again another upon the spindle of the escape-wheel S. The escape-wheel operates upon two arms or "pallets," A A, and by their means passes on impulse to the pendulum. For a clock with a seconds' pendulum there are generally thirty teeth in the escape-wheel, and as one tooth passes either pallet at every other vibration of the pendulum, you will see that it turns once in a minute, and its spindle carries the seconds' hand. The numbers of teeth in the escape-pinion, third wheel, third pinion, and centre wheel are so arranged that the centre-wheel turns once for every sixty turns of the escape-wheel, that is, once in an hour. The great wheel which engages the centre pinion turns once in twelve hours, and for an eight-day clock there are, of course, sixteen turns of the line upon the barrel.

Fig. 5 shows the apparatus for obtaining the relative motions of the hour and minute-hands. Upon the spindle S S of the centre-wheel (which you recollect turns once in an hour) is placed, friction-tight (that is, so stiff that it clings to the spindle, and yet loose enough to be movable by

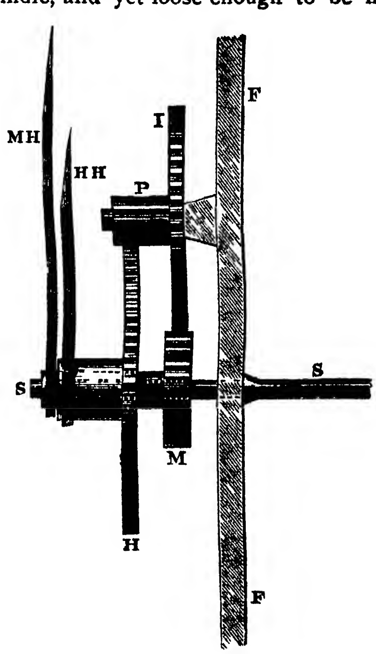

Fig 5

hand), the wheel M, with a long socket reaching through to the left which carries the minute-hand M H at its extremity. This wheel gears with another, I, which it moves round in twice its time, *i.e.*, in two hours. Connected with this second wheel is a pinion, P, and the wheel H (which rolls upon the socket of the wheel M), gears into it. This wheel is arranged to move round six times as slowly as the pinion P, that is to say, in twelve hours, and it carries a socket to which the hour-hand H H is attached. The socket-wheel, M, being on the spindle of the centre-wheel, only friction-tight, you can, of course, shift the combination without disturbing the clock-train.

The barrel, B, is connected with the great wheel by means of a ratchet-wheel and click (see Fig. 4). The ratchet-wheel, R_1, is fastened to the barrel, and when you wind up the weight by turning the barrel, its teeth being pointed backwards, pass under the click L. When you cease winding, the square face of the tooth meets the click, and communicates pressure through it to the great wheel.

But when you wind the clock, you relieve the great wheel from the strain of the weight, and the clock would stop if you did not introduce mechanism to prevent it. Fig. 6 represents such mechanism.

In this case the click L is fastened not upon the great wheel G G but upon an additional ratchet-wheel, $R_2 R_2$, which rides loosely upon the axis of the great wheel. Its

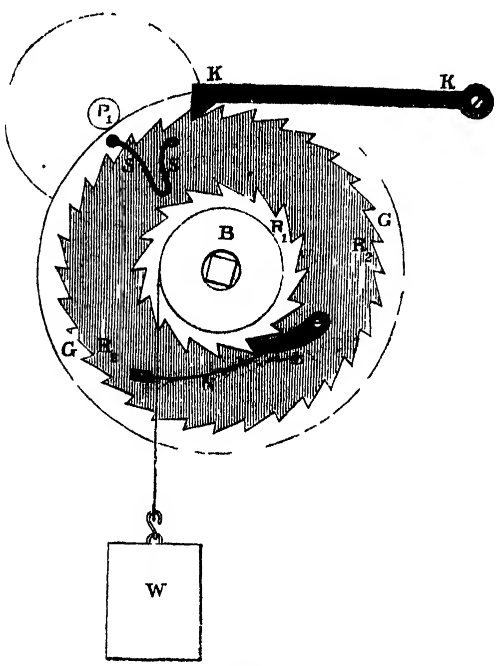

FIG. 6.

teeth, which point in the reverse direction to those of the first ratchet-wheel, pass under the long click K K mounted within the clock frame, and so far as the driving power of the clock weight is concerned, its action may be neglected altogether.

This ratchet-wheel is connected with the great wheel only by the spring S S, one end of the spring being fastened to the great wheel and the other to the ratchet-wheel. The strain of the clock weight keeps this spring closed and is transmitted to the great wheel through it.

Let us see what will happen when we try to wind. The spring S S is relieved from the strain of the weight and essays to open by thrusting back the ratchet $R_2 R_2$, but this it cannot do, for the long click K K prevents it, and banking against this the thrust of the spring is transferred to the clock-train.

Other mechanism is also employed for the purpose.

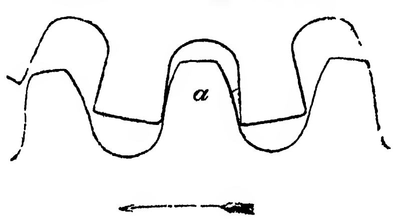

FIG. 7.

One very favourite plan (a very old one, which has been once or twice re-invented lately) places the fulcrum of the lever (in other words, the spindle of the wheel) through which the barrel is wound, upon the great wheel itself.

Great care has to be taken both in shaping and sizeing the various wheels and pinions. It is an advantage to have high numbered pinions, because in this case you do not get so oblique an action of the wheel teeth upon the teeth of the pinions: the action is more across the line of centres.

The curves of the teeth must also be properly formed. The broad principle is to get an uniform running, that is, that the pinion shall always move at a fixed and definite rate with regard to wheel, for if it moves faster or slower it is quite clear that the wheel tooth is acting too far up or too low down the flank of the pinion tooth, that is to say, working it at the end of too short or too long a lever; and less or more power is accordingly transmitted. If you look at Fig. 7 you will see easily that if the top of the wheel tooth *a* were not rounded off quite so much it (supposing the present curve correct) must drive the pinion too fast, and too little power would then be delivered.

Sometimes the main clock-train is merely employed to wind up at certain short intervals (usually twice a minute) a subsidiary weight or mainspring, which latter is that which immediately propels the escape wheel. In this manner variations in the friction of the clock-train can

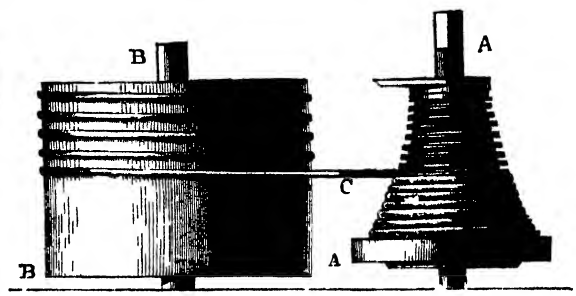

FIG. 8.

be in great measure prevented from reaching the pendulum, if there is a little less or more power upon the clock-train, the only effect being to wind up the subsidiary weight or spring more or less rapidly. The main clock-train is at the right moment liberated by some mechanism upon the spindle of the escape-wheel and the minute-hand being connected with it moves by jumps whenever the weight or spring is wound up.

The general arrangement of the train of watches and chronometers differs little from that of clocks, but the power is delivered by means of a coiled spring, which necessitates the following arrangement.

The spring pulls harder the further you wind it, and its force at commencing would be obviously greater than when it has in part run down; we therefore introduce the following compensation (see Fig. 8). We place the great wheel upon that hollow-sided cone or "fusee" A A, and connect it with the barrel B B (which is impelled by the main spring inside it) by means of a chain, C. When the spring pulls hardest it has the thinner part of the fusee to act upon, it works a lever of shorter radius, and the force at the circumference of the great wheel is in this manner equalised.

(*To be continued.*)

FLORIDA SHELL MOUNDS[1]

THE river St. John drains the eastern portion of the northern half of the peninsula of Florida, running northward over a flat country for a distance of about 300 miles. In the lower part of its course it opens out into large sheets of water two to three miles in width, and as might be expected from the nature of the country, it frequently shifts its bed, and is liable to annual inun-

[1] Fresh-water Shell Mounds of the St. John's River, Florida. By Prof. Jeffries Wyman. In the Memoirs of the Peabody Academy of Science. Vol. I. No. 4.

dations which place large tracts of the surrounding country under water; indeed it is said that a depression of ten feet would cover the whole of this part of Florida by the sea.

It is not until the river begins to narrow its channel near Palatka that the shell mounds which form the subject of this memoir begin to appear, and they then continue at intervals along the banks of the river as far south as Salt Lake. They always are, or have been at one time, on the river bank, although the latter has in some places removed from them, and in others encroached so as to totally destroy or cut deeply into their sides, and as is frequently found to be the case with prehistoric fishing habitations elsewhere, the junction of the river with the lagoons was often selected as a place of residence. Most of the mounds are in the form of ridges parallel to the shore, fifteen, twenty, or twenty-five feet in height, flat-topped, and some of them covering several acres of ground; others are circular; and others again form shell-fields having their materials more evenly distributed, and not more than two to three feet in thickness.

They are composed almost entirely of fresh-water shells of three species, viz., *Ampullaria depressa*, Say; *Paludina multilineata*, Say; and *Unio buckleyi*, Lea. Of these the paludina forms by far the largest portion of every mound, and with a few unios the whole of some, but deposits of either of the above species are occasionally found alone instead of being promiscuously mixed

with the others, showing that probably at certain times they had been used exclusively for food. All three species are now found inhabiting the rivers and creeks, and more particularly the lagoons, the bottoms of which are sometimes covered with them, and yet they are not now found in such abundance as to suffice for the creation of such large mounds, from which it must be inferred either that the construction of the mounds must have been spread over a long period of time, or what is equally probable from the known habits of shell-fish, that they must have existed in greater abundance formerly. It was also noticed that the *ampullariæ* and *paludinæ* in some of the shell mounds were much larger than their living representatives. These observations remind us of similar changes which have been noticed as having place in the size and distribution of the shell-fish found in the kitchen middens of Denmark.

The mounds consist solely of refuse heaps of food, and were not thrown up for any other purpose, which is proved by finding hearth-stones with charcoal, and the remains of the bones of animals used for food at different levels throughout the mass. The animal remains consist of the following species, viz.:—bear, raccoon, hare, deer, otter, opossum, turkey, alligator, hard and soft-shelled turtle, box-turtle, gopher, catfish, gar-pike, whiting, and other birds and fish not determinal. No trace of domesticated animals has been discovered, nor does the dog anywhere appear in the shell mounds, and there is no evidence that agriculture had been introduced. A few bones of mastodon, horse, ox, and other animals now extinct in this region have been found, but their condition has led the author to think it certain that they do not belong to the age of the mounds, and may perhaps have been scooped up from the bottoms of the creeks with the shells taken for food. Fragments of human bones found scattered here and there in the mounds, and broken up in the same manner as the bones of edible animals, lead to the inference that the constructors of the shell-heaps were cannibals, which is rendered all the more probable by the known prevalence of this custom throughout the two continents of America.

Only one skull of the builders has been found; this differs from the skulls of the burial-mounds in being longer, with the ridges and processes more pronounced, but does not afford sufficient data for forming any opinion as to the physical peculiarities of the race. Platycnemism has been found to exist in several of the bones here, as well as in skeletons from Kentucky, Labrador, Michigan, and California, but the author's researches on this point lead him to think that this peculiarity cannot be considered as forming a race-character amongst the Indians, as it exists also amongst the white race, several sections of the tibias of whom, by the side of those of Indians, are given in the work.

Amongst the relics of human industry discovered in the mounds, stone implements are rare and generally of rude form, consisting of chips, flakes, stone hammers, and a few implements resembling the drift types of Europe, which last may, however, have been unfinished specimens. Arrow-heads of four or five different forms are described, viz. (1), triangular with a straight base, (2) triangular with a notched base, (3) with a stem or tang, and (4) triangular with notched sides; also a few rude leaf-shaped implements, which may have been used for this purpose. Unfortunately, illustrations of these are not given, but it may be observed that the triangular arrow-head with side notches is a form which is almost exclusively confined to America, being common throughout the United States and in Patagonia. The bone tools consist chiefly of awls, the ulna of the deer being a favourite bone for this purpose; fragments of stag's horn are also found cut round the outside and broken off, and also with longitudinal incisions for the purpose of detaching long pieces suitable for making pins.

The shell tools are made exclusively of marine species, viz., the *Strombus gigas*, and two species of *Busycon*, found abundantly on the Atlantic and Gulf coasts, and known to have been used in prehistoric trade as far north as the great lakes. They appear to have been held in the hand, and are spoken of by Le Moyne and Cabeza de Vaca as implements employed by the Indians for cutting wood.

Pottery is found only in the later mounds in small fragments and is composed of clay mixed with a vegetable fibre; the vessels were all hand-made, and appear to have been formed in irregular curves and of uneven thickness, generally flaring at the mouth, and sometimes ornamented with incised lines. One fragment, of which an illustration is given, appears to deserve more attention than is given to it in the memoir. It is ornamented with a loop-coil clearly but rudely traced, forming a fragment perhaps of the class of ornament known in architecture as the Vitruvian scroll. The distribution of the use of this ornament occupies, so far as we have been able to trace it, a continuous geographical area. It is common in Peru, Mexico, Colorado, Arizona, and amongst some of the tribes of the northern part of South America, and its occurrence here is of interest, as affording perhaps the most reliable evidence of connection with the arts of the races to the south and westward.

Like the kitchen middens of Denmark, these shell-heaps were, for many years after their discovery, con-

sidered to be of natural origin. Little or no notice of their contents appears to have been taken until the examination of them by Prof. Wyman, in 1860 and 1867. They are now for the most part covered by a thick forest-growth, the chief trees being oaks and palmettoes, with many shrubs and vines. The age of some of the oaks growing upon the mounds has been estimated by their annual rings at 400 years, and one, a gigantic one, at 666 years. Taking this into consideration, together with the changes in the channel of the river, the formation of new land, and the extension of plants and trees over it, Prof. Wyman thinks that an antiquity of a thousand years would not be an unreasonable age to allow for the earliest shell-mounds.

OUR ASTRONOMICAL COLUMN

THE VARIABLE STAR 34 CYGNI, NOVA 1600.—This star, although an object of pretty frequent meridian observation, has probably received less attention than most others from those observers who especially occupy themselves with the variable stars, owing to the circumstance of the estimates of magnitude recorded at transit having been remarkably accordant for upwards of a century. Indeed since the year 1750, on examining the catalogues, we find in the majority of cases that the star is estimated 5½, the only marked exception being Bessel's observation in his zone 1825, September 14, when it is called 6·7.

If, however, we examine the earlier history of this star, we see there are some grounds for suspecting that one or more maxima may have escaped observation, unless the irregularity of variation attributed to it, in the recent catalogues of such objects be very great.

The discovery of the star is ascribed to William Janson, who had marked it on a celestial globe in 1600, as we learn from Kepler ("De Stellâ tertii honoris in Cygno," appended to his well-known work, "De Stellâ novâ in pede Serpentarii," which appeared in 1606). Kepler himself was not aware of its existence till May, 1602, and he enters into an explanation which is, to an extent, apologetical, for his not having previously remarked it. At the same time he calls it a *new* star, and in proof of its being so, adduces, in addition to Janson, the authority of Justin Byrgius and Bayer, who, by the way, has attached the letter P to the star in his "Uranometria," and is followed by Prof. Schönfeld. By observations in August, 1602, he fixed its position in R.A. 300° 46′, Decl. 36° 52′, which agrees closely with the modern catalogues. He calls it a third magnitude in 1602, and states that it continued of the same brightness during the nineteen years over which his observations extended; it was not quite so bright as γ Cygni, but was brighter than β in the same constellation.

According to Liceti it appeared again in 1621, afterwards diminishing, until lost altogether. In 1655 it was observed again by Dominique Cassini, and gradually brightened during five years, until it attained the third magnitude, and subsequently diminished. Hevelius states that it reappeared in November, 1655; it was still very small in 1666, afterwards becoming brighter, though without reaching the third magnitude. In 1677, 1682, and in 1715 it was estimated a sixth magnitude, and there is no further record of its increase to the maximum of 1602.

Pigott assigned a period of eighteen years, which but imperfectly represents the observations of the seventeenth century.

Schönfeld remarks that it is doubtful whether the star had its actual brightness before the year 1600, or was invisible; perhaps the former condition will be considered the more probable, notwithstanding Kepler's account of its having escaped his observation from the year 1591, when he commenced the study of the heavens under Mæstlin, and noted but one conspicuous star in the breast of the Swan.

Probably a systematic observation of 34 Cygni may lead to the record of another maximum. The star is of a deep yellow colour, and its position for the beginning of 1877 is in R.A. 20h. 13m. 15s., N.P.D. 52° 21′.

Its neighbour χ (Bayer) Cygni, deserves special attention at present, the fluctuations of brightness for some years past having been quite exceptional. Its position is in R.A. 19h. 45m. 50s., N.P.D. 57° 23′ for 1877·0.

THE INTRA-MERCURIAL PLANET QUESTION.—M. Leverrier made a further communication to the Paris Academy, on the 2nd inst., with reference to this subject. Having collected in his previous communications, chiefly from the original authorities, such observations as could be supposed to bear upon it in any way, he finally selects for discussion those only which, in addition to the roundness and blackness of the spots, have distinct mention of sensible change of position upon the sun's disk on the day of observation. There are ten cases under this head in the months of January, February, March, May, and June, or possibly beginning of July, and October. M. Leverrier remarks it is inadmissible that a body projected upon the sun on February 12, which is the date of the observation by Steinheibel mentioned in the correspondence between Olbers and Bessel, could repass at the end of March or beginning of October, *i.e.*, when arriving in the line of nodes of the objects seen by Lescarbault and Lummis. This could only happen if the first body moved in an orbit very little inclined to the ecliptic, but in this case the necessary frequency of the transits must have led to its being more often observed. For the present, therefore, he confines himself to treating five observations in October and March, where motion like that of a planet in transit are recorded. His data stand thus:—

Decuppis,	1839, Oct. 2·0	... ..	Helioc. long.,	8°·60
Fritsch,	1802, Oct. 10·0	.. ...	,,	16·46
Sidebotham,	1849, March 12·18	... ...	,,	172·01
Lummis,	1862, March 19·87	... ...	,,	179·86
Lescarbault,	1859, March 26·22	... ...	,,	186·60

And it is found that these five longitudes are represented with all the precision permitted by the nature of the observations by the formula (ν = helioc. longitude)—

$$\nu = 121^\circ{\cdot}49 + 10^\circ{\cdot}9017834\, j - 0^\circ{\cdot}52 \cos.\ \nu,$$

j being reckoned in days from 1750·0.

The differences between calculation and observation are:—

[illegible]	...	+ 3°·6	1849	...	+ 3°·5
1802	...	− 3·6	1862	...	+ 0·8
			1859	..	− 4·6

None of the residuals exceeding a half-day's motion, M. Leverrier thinks it permissible to infer that the five observations appertain to the transits of the same body.

With the above motion the period of revolution is 33·0225 days, and the semi-axis major 0·201.

The existence of an intra-Mercurial body announced by theory, being, according to M. Leverrier, beyond doubt; to use his own words, "nous voilà desormais en possession de données permettant dès à present de constituer une première théorie qui conduira à retrouver la planète avec facilité et à la faire rentrer dans le système régulier des corps célestes." In conclusion he states that he is now occupied in determining the epochs of the next following transits over the sun's disk.

NOTE ON THE SUN-SPOT OF APRIL 4, 1876

(*Communicated by the Astronomer Royal*)

ON the publication of Herr Weber's observation of a round spot seen on the sun on April 4, reference was made to the photographs taken at the Royal Observatory, Greenwich, on the morning of that day, and it was remarked at once that there was a small round spot

in a group of faculæ near the north-east limb in the place indicated by Herr Weber's observation. The position of the spot has now been measured on the two photographs, which were taken at 21h. 46m. 35s. and 22h. 1m. 4s. Greenwich mean time respectively, and the following are the means of the two sets of results which agree very closely:—

1876, April 3d, 21h. 54m.

Distance from sun's centre along arc of parallel	788″
Diff. of R.A. (Spot − ⊙)	+ 52s·3
Diff. of N.P.D. (Spot − ⊙)	− 218″·5
Distance from sun's centre	817″
Distance from N.E. limb	145″
Diameter of spot	4″

As Herr Weber's observation was made at 4h. 25m. Berlin mean time, or 3h. 31m. Greenwich mean time, the sun's rotation in the interval—5h. 37m.—would have carried the spot to a distance of about 163″ from the limb, as appears from a rough computation, and thus the position would agree tolerably well with that given by Herr Weber. There can be no question that the spot on the Greenwich photographs, which is the same as that observed by M. Ventosa, is an ordinary sun-spot without penumbra, and not an intra-mercurial planet.

Royal Observatory, Greenwich, October 4

CAUTIONS AS TO INTRA-MERCURIAL OBSERVATIONS

AT the Paris Academy on the 2nd instant, Dr. Janssen read a paper containing some very timely cautions as to the observation of the transit of intra-Mercurial bodies across the sun. He maintains that we have the means of investigating the problem which at present is interesting astronomers of a most satisfactory kind and leading to a certain and rational result. The first of these means is the knowledge we now possess of the solar envelope, and the second is photography. A criterion of a true transit is that the spot be well rounded against the solar disc, that it have a rapid displacement on the surface of the disc, a motion quite different from the apparent motion of solar spots. These requirements would eliminate a great number of doubtful observations, and even then the transit might not be a real one. Many solar spots are distinctly rounded, but then error is apt to creep in in the observation of the proper movement, especially when the observation is made with a telescope having no equatorial mounting, the diurnal motion making the spot appear to be constantly changing place. The rapid disappearance of a spot is no proof that it is outside the sun; at the minimum period spots have a tendency to dissolve rapidly. It follows that the isolated observations made by persons who have no thorough knowledge, or who have not suitable instruments, are comparatively valueless. While giving the highest place to photography, Dr. Janssen thinks telescopic observations of so great importance that he gives some hints for the guidance of observers.

There are circumstances connected with the constitution of the photosphere which may afford guidance even in fugitive observations. Briefly, as a solar spot is a phenomenon of the photosphere, a disturbing phenomenon at the highest point of the region where it is produced, it follows that the ordinary aspect of the photosphere is modified all round it. Moreover, if the spot is sufficiently distant from the centre of the disc, it ought to present the perspective effects of an object placed upon the vanishing surface of a globe. Finally the region of the sun where the spot appears ought to be attended to, to discover its solar latitude, since we know that the spots are located in two main regions, to the north and to the south of the sun's equator. More valuable still is the following test. It is evident that a moving body interposed between our eye and the solar surface ought to produce a succession of eclipses of the granulations covering that surface; to cover successively those towards which it moves and uncover those on the opposite side. This phenomenon of emersion and immersion is the most decisive of all tests of the value of a brief observation; it requires, however, a good instrument of considerable power. Dr. Janssen advises moreover that the regions around the sun's disc to three or four minutes angular distance should be explored with the greatest care; as at that distance the coronal atmosphere is bright enough for a body of a fraction of a minute in diameter to give a visible eclipse. A trustworthy observation of a body seen either entering or leaving the sun's disc under such circumstances, is of the very highest value; moreover the field of observation is thus greatly increased. But eye observations of the sun must at best be but isolated, and photography furnishes the only sure method of unerring, precise, authentic observation, surpassing in value that of the ablest astronomer.

The question of intra-Mercurial bodies shows once more the immense importance of obtaining uninterrupted international observation of the sun's face. Hence the value of a mechanical photographic revolver that would, every hour, say, photograph the sun, without requiring the interference of any one. A number of these distributed over the globe would, in a few years, give us such a knowledge of the sun's surface as it would be impossible to obtain under any other circumstances.

RUSSIAN EXPLORATION IN ASIA DURING THE PAST SUMMER

THE following information as to the different scientific expeditions sent during the past summer by the Russian learned societies for the exploration of various parts of Russia and of the adjacent territories will probably be of interest. We begin with Central Asia, leaving for another paper the report upon the proceedings of the expeditions to the Obi and Jenissei.

M. Prshevalsky has left Omsk, and we have already given some account of the scientific staff of the expedition and the route he proposes to follow.

M. Severtsoff, as reported by the *Turkestanskija Vedomosti*, was to begin his travels in the Fergana district and in the adjoining hilly tracts during this autumn. He will be accompanied by M. Sharz, astronomer, M. Mushketoff, mining engineer, M. Smirnoff, botanist, M. Skvortsoff, zoologist, one topographer, and six Cossacks. During next summer he proposes to explore the Alai and the mountains south of Kokan, and to penetrate about the autumn into the Pamir, reaching here the route followed by the members of Mr. Forsyth's expedition.

M. Potanin, as reported by the *Sibir*, reached Omsk on June 27. The object of his expedition is the geographical, ethnographical, and economical exploration of North-western Mongolia, for which purpose 9,400 roubles were allowed by the Geographical Society and by the Government. He will be accompanied by his wife, M. Posdnéeff, linguist, M. Raphailoff, topographer, M. Beresoffsky, volunteer, and M. Kolomiitseff, zoologist, sent by M. Severtsoff. Starting from the Zaisansky post on the Irtish, M. Potanin will follow the steppe-valley of the Black Irtish and proceed to Urumga, Khobdo, the Oobsa-nor. For winter-quarters he will then go south, through Oolassootai to the eastern parts of the Tian Shan. During the following summer, taking a northern course, the expedition proposes to reach the sources of the Jenissei and the Kossogol lake, returning south again for the winter to the eastern foot of the Shangai-alin and to the expansion of the Onguiin river. During his stay in Omsk, M. Posdnéeff has assiduously visited the town's archives, and has found some very interesting documents; for instance, letters from the Telengoot chiefs written in Kalmuck with Mongolian alphabet, whilst now the Telengoots do not use any written language.

of these schools are unaided by the State and have to rely mainly upon the fees of the students, supplemented by subscriptions from the manufacturers, they can vie with some of the best equipped scientific laboratories of the Continent in the character of their organisation and in the completeness and extent of their arrangements. An effort is about to be made to secure a portion of the surplus in the hands of the Commissioners of 1851, with a view to the further extension and development of the College. They had established a number of chairs more or less connected with the necessities of the manufacturers of the district, but they required extension in the direction of other subjects, many of which doubtless lay nearer to the basis of sound education. Their buildings were rapidly getting inadequate to their requirements, and they wanted additional lecture-rooms, and a good library. Prof. Rücker, speaking for himself and his colleagues, believed that the greatest want of the institution was not so much that a large sum of money should be devoted to further scientific objects, but that a portion of the money should be spent in the furtherance of other objects of education besides those which were scientific. They found practically that they were hampered in their work by the fact that they were unable to offer to the students that came to the college a complete preparation for the curriculum which they would have to go through at the universities. The Council of the College had found themselves in a position to add to the scientific chairs which they had already founded, and he trusted that they would soon be able to create chairs for classics, modern languages, and literature.

A KIND of supplement is about to be issued regularly along with *Poggendorff's Annalen*, under the title of *Beiblatter zu der Annalen der Physik und Chemie*, the object being chiefly to give a *résumé* of physical science in foreign countries.

FROM a letter received from Prof. Mohn, we learn that hourly meteorological observations of all the elements have been made by the Norwegian Scientific Expedition during the whole cruise. In the hands of this distinguished meteorologist the invaluable data thus acquired will doubtless be made to tell us something regarding the daily periods of the meteorological elements, including the surface temperature and density of the northern portion of the Atlantic, and the part they play in the meteorology of North-Western Europe.

THE unusually high temperature which prevailed over the British Islands during the latter part of last week deserves a passing notice. The mean temperature from October 4 to 7 was 62° in London, and 59° in East Lothian, being 8° and 9° respectively above the average of the season. The Weather Maps of the *Bulletin International* of Paris and of the *Deutsche Seewarte* of Hamburg, show for these days a high atmospheric pressure over all Europe southwards and eastwards, whilst a pressure continually getting lower was met with on advancing westwards over the British Islands. These are interesting as the meteorological conditions which are the immediate cause of unusually mild warm weather at this season of the year, seeing they necessarily result in an extensive southerly atmospheric current, bearing northwards with it the high temperature and moisture of southern latitudes.

THE fourth number of the *Isvestia* (Bulletin) of the Russian Geographical Society, just appeared, contains a sketch of the Guissar region and of the Koolab-beckdom, by M. Maieff; letters of the governor of the Semipalatinsk province, by General Poltaratzky; on the German expedition of Dr. Finsch, Dr. Brehm, and Count Waldburg-Zeil; and two letters from Dr. Miclucho Maclay written on board the schooner *Sea-Bird*, and dated February 29 and April 12. Desirous of obtaining further information as to the races of South-eastern Asia, the East Indian Archipelago, and of the Pacific Islands, Dr. Maclay wished especially to visit the islands of Western Micronesia and the group of little-known islands lying between New Guinea, New Ireland, and New Britain, these islands being, it is supposed by certain ethnologists, near to the route taken by the Malayo-Polynesian race before spreading over the islands of the Pacific. The *Sea-Bird*, at the time the letters were written, was going to the western islands of the Caroline Archipelago, stopping from time to time at the more interesting localities lying near to her course; and after having discharged her cargo she will be for some time at the disposal of Dr. Maclay, for his proposed journey.

THE members of the scientific expedition sent for a further exploration of the former bed of the Amu-arya, left the Krasnovodsky post on August 22, with a reconnoitring military party proceeding to the Steppes under General Lomakin.

WE are glad to learn from the Mauritius *Commercial Gazette* that Mr. John Horne, F.L.S., who for a long time has most successfully fulfilled the duties of director of the Mauritius Botanical Gardens, has been confirmed in the appointment. This promotion we believe to have been thoroughly well earned.

VISCOUNT WALDEN, President of the Zoological Society, has, by the death of his father, succeeded to the Marquisate of Tweeddale.

THE death is announced of the Chevalier Pertz, for many years librarian to the Royal Library, Berlin, and editor of the *Monumenta Germanica*. He was brother-in-law to the late Sir Charles Lyell.

THE *Reports of the Meteorological, Magnetic, and other Observatories of the Dominion of Canada, for* 1875, appear in a thick volume of 541 pages, giving full details of the tri-daily observations and monthly extremes and means for the year at various stations, now amounting to 108. The report gives evidence throughout of increasing energy and efficiency in this valuable system, the object of which is the collection of meteorological statistics suited for the discussion of physical questions, and the deduction therefrom of the climatic character of the several districts, and the application of the facts and principles thus acquired to questions of practical utility, especially the prognostication of the weather. The new features of this report are a table of the latitudes, longitudes, and heights of the stations, and tables of the maxima and minima of temperature at the more important stations in the dominion for each day of the year. Among the interesting facts noted is the low temperature of 49°·5, which occurred in January at York Factory, on Hudson Bay, the mean for the month at the same place being −25°·5, and for February following, 24° 6.

MR. CHARLES TODD has issued in a separate form his paper "On the Observatory and Climate of South Australia," originally published in the "Handbook of South Australia." Perhaps no other of our English colonies could be named whose climate has been more ably and, so far as the materials hitherto collected admit of it, more exhaustively treated than that of South Australia in this tractate. The rainfall of the colony is now being investigated at upwards of seventy observing stations extending over the whole breadth of Australia, as is also the annual southerly march of the north-west monsoon which prevails on the north coast from about the middle of November to March, and occasionally extends its influence in heavy thunderstorms right across the continent. Among the many interesting relations subsisting between the meteorology of South Australia and that of surrounding regions may be noted the progressive changes of the barometer which, roughly speaking, advance from west to east at such rates as to occupy from two to four days in passing from Western Australia to Adelaide, after which they reach Melbourne in from twelve to twenty-four hours, and

Sydney and Brisbane in about twenty-four to forty hours. The importance of this in a system of weather warnings for Australia need scarcely be pointed out.

A LINNEAN Society was recently established in New South Wales, and now numbers, in addition to a president (Mr. W. Macleay), vice-president, secretary, treasurer, and council, about 120 members. Its first meeting was held on January 25, 1875, and it now publishes the first part of its first volume of *Proceedings*. Among the papers are contributions to the Malacology of Australia and the Solomon Islands, by Mr. Brazier; to our knowledge of the stone implements of Australia and the South Sea Islands, by Dr. Cox; description of a new genus and species of rat-kangaroo (*Hypsiprymnodon moschatus*), by Mr. E. P. Ramsay; and, by the same author, of a new genus and species of Passerine bird (*Vitia ruficapilla*), from the Fiji Islands; notes on zoological collections made in Torres Straits and New Guinea during the cruise of the *Chevert*, &c. The botany of the colony appears at present to have furnished nothing to the Society, to which we wish a prosperous career.

MR. W. J. BEAL reprints in one cover three papers read before the American Association for the Advancement of Science at the Detroit meeting:—Carnivorous plants, Inequilateral leaves, and the Venation of a few odd leaves. Mr. Beal includes *Martynia* in the list of true carnivorous plants.

THE fourth annual edition has appeared of Prof. E. Morren's extremely useful "Correspondance botanique," a list of all the botanic gardens in the world, with the officers connected with them, and the various other establishments for instruction in botany.

THE following curious experiment has recently been described by M. Spring to the Belgian Academy:—A sheet of vulcanised caoutchouc two-tenths of a millimetre thick is stretched till its surface becomes six or seven times greater, then rubbed with a cloth. This friction electrifies the sheet so that it will readily attract light bodies. If now the mechanical tension of the sheet be gradually diminished, the quantity of electricity diminishes along with it, until when the band has recovered its original length, all trace of electricity disappears (provided the original charge have not passed a certain limit). M. Spring concludes that the variations of electric state of the band are intimately connected with molecular changes experienced interiorly according to the degree of tension. The experiment is one which deserves the attention of physicists.

THE recent number of the *Schriften der naturforschenden Gesellschaft in Dantzig* contains several excellent photographs of the skeleton of a whale (*Pterobalæna laticeps*, Gray), stranded in Dantzic Bay in 1874; a description of the spiders of Prussia; a lecture by M. Ohlert on Laplace's hypothesis, and an account of acoustical studies on the piano, by M. Kayser.

M. SKALWEIT, of Memel, relates in the publication just named that in summer he observed a wasp flying about a writing desk near an open window. There were some steel pen-holders on the desk, and the wasp went into one of the tubes. This must have appeared convenient to it, for it soon began to bring in small caterpillars, building each in with earthy paste, till the tube was full. In each cell an egg was also deposited. M. Skalweit took away this holder, and put another in its place. This was similarly filled by the wasp, though in rainy weather and at night the window was closed. Four holders were thu filled. Opening the holders in the end of August, M. Skalweit found the larvæ grown and the caterpillars consumed. The wasp in question was the *Odynerus parietum*, which generally constructs its cells in old fence-posts, hollow plant-stems, old walls, &c.

AN improved catalogue of variable stars is published by Prof. Schönfeld in the thirty-ninth and fortieth *Jahresbericht des Mannheimer Vereins für Naturkunde* (Mannheim, 1876). It is largely based on his own observations.

THE extraordinary divisibility of matter is well illustrated by a lecture experiment recently described to the Berlin Chemical Society by M. Annaheim. He employs the strong colouring power of fuchsin and cyanin. To form an idea what quantities of colouring matter were still perceptible by the eye, he dissolved 0·0007 gramme of fuchsin (a particle about 0·5 mm. diameter) in spirit of wine, and diluted the solution to the extent of 1,000 cubic centimetres. Thus in each centimetre there was still 0·0000007 gramme colouring matter. If this liquid be put in a burette of about 1 cm. diameter, it appears strongly coloured on a white ground, and the colour can be distinctly seen from a distance. If a drop from the burette (there are thirty-five of them in a cub. ctm.) be now let fall into a small dry test-tube of about 0·8 cm. diameter, the red colour is still evident if the tube be held obliquely on white paper, and looked at parallel to the paper, while a second tube with pure spirit of wine is held near for comparison. It follows from this, that with the naked eye one can still perceive 0·00000002 gramme fuchsin. Assuming that one drop of the solution only contains one molecule of colouring matter (and so much must in all circumstances be present), the absolute weight of an atom of hydrogen is inferred to have the astonishingly small value of 0·000000000059 gramme (viz. 0·00000002 : 337·5; molecular weight = 337·5). M. Annahein makes a similar experiment with cyanin, and infers the absolute weight of an atom of hydrogen to be 0·000000000054 gramme, which closely agrees with the former estimate. From these experiments, then, it is mathematically certain, that the absolute weight of an atom of hydrogen cannot be greater than 0·00000000005 gramme.

THE number of visitors to the Loan Collection of Scientific apparatus during the week ending October 7 was as follows:—Monday, 2,186; Tuesday, 1,767; Wednesday, 239; Thursday, 252; Friday, 200; Saturday, 2,439. Total, 7,083.

THE Catholic University of Lille has been at last organised, but the governors of the Sainte-Eugénie Hospital having refused to establish a ward for their use, there can be no Faculty of Medicine. Consequently the University authorities, it is said, are to prosecute the governors before the Council of State in order to obtain the requisite number of patients.

A CORRESPONDENT of *Land and Water* shows that some of our most recent inventions were foreshadowed, if not actually accomplished, upwards of 300 years ago. In a work, "Vegelhi Renoti (Flavii) viri illustris de re militari libri quatuor, etc. Parisiis subscuto Basiliensi ex officina Christiani Wecheli, M.D.XXXV.," are figures of a number of military engines, which we work very hard at reinventing. Amongst others there is a revolving gun, revolving turrets for monitors, water-beds for the wounded, &c. The first plate of Book III. shows a warrior habited in a "Boyton dress," completely immersed in water, but without apparent means of breathing. In the second plate is a diver with a reservoir of air, and tube communicating with the surface. There are several representations of these "tube and reservoir" apparatus, and diving dresses An engraving not only shows the submarine explorer of more than 300 years ago at work, but also gives the diagram of a diving-bell, according to the notion of some engineer of the early part of the sixteenth century.

THE Session of the Watford Natural History Society and Hertfordshire Field Club commences this evening with a lecture "On the Polarisation of Light," by Mr. James U. Harford.

THE storm of the end of September raged with such terrific force at Dijon (Côte d'Or) on the 30th at 2 o'clock in the afternoon, that two turrets on the cathedral were thrown down.

M. KRANTZ intends to imitate on a smaller scale the great Hell Gate explosion by opening in a similar manner the ground of the Champ de Mars, and thus expediting the excavations for the erection of the basement of the Exhibition building.

THE French papers give some figures with reference to the iron framework of the building now constructing. The weight required for the machine gallery will be 17,000 tons, and for other galleries 10,000 tons. To these 27,000 tons of iron or cast-iron may be added 700 tons of sheet iron for covering the building. The superficial extent of carpenter work for battening the roof will be 90,000 square yards covered with zinc. The quantity of the wood necessary is about 2,000 cubic yards. The number of rivets used for bolting the metallic frame will be 11,000,000, and the number of holes to be perforated a little more than double, viz., 23,000,000.

AMONG the lectures to be given at the Nottingham Literary and Philosophical Society during the coming winter, are one by Dr. Ball, F.R.S., November 9, "A Night at Lord Rosse's Telescope," and another on December 7, by Dr. M. Foster, F.R.S., "On Nerves."

THE following are some of the scientific works to be published during the coming season:—The second series of Mr. George Henry Lewes' "Problems of Life and Mind," entitled "The Physical Basis of Mind," is in the press, and will be published by Messrs. Trübner. The same publishers are preparing for publication in December, "Theoretical Mechanics," a Manual of the Mechanics of Engineering and of the Construction of Machines, with an Introduction to the Calculus; designed as a text-book for technical schools and colleges, and for the use of engineers, architects, &c., by Julius Weisbach, Ph.D., Professor at the Royal Mining Academy at Freiberg. It is translated from the fourth augmented and improved German edition by Eckley B. Coxe, A.M., Mining Engineer. With woodcuts.—Messrs. Bentley and Son have in the press a narrative of travel in Norway and Lapland, by Mr. S. H. Eden, to be called "Within the Arctic Circle."—We are glad to notice that Messrs. Chatto and Windus are preparing a new edition of "Wilson's American Ornithology; or, Natural History of the Birds of the United States;" with the continuation by Prince Charles Lucien Bonaparte; completed by the insertion of above one hundred birds omitted in the original work, and illustrated by notes and a life of the author by Sir William Jardine.—Among Messrs. H. S. King and Co.'s announcements we observe:—"The Large and Small Game of Bengal and the North-Western Provinces of India," by Capt. J. H. Baldwin, F.Z.S., Bengal Staff Corps, with numerous Illustrations. "Studies in Spectrum Analysis," by J. Norman Lockyer, F.R.S., "The Races of Man and their Geographical Distribution," from the German of Oscar Peschel. This last-named book is ready.—Prof. Tyndall's "Lessons in Electricity at the Royal Institution," will be published by Messrs. Longmans at the end of this month.

THE additions to the Zoological Society's Gardens during the past week include two Silky Marmosets (*Hapale chrysoleucus*) from S.E. Brazil, presented by Master T. A. Brassey; a Green Monkey (*Cercopithecus callitrichus*) from W. Africa, presented by Mr. Chas. L. N. Ingram; an Entellus Monkey (*Semnopithecus entellus*) from India, presented by Mr. Edwin Penn; two Coatis (*Nasua nasica*) from S. America, presented by Mr. J. A. Watson; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. Graham M. Sutton; four European Terrapins (*Clemmys europea*), European, presented by Mr. Edward W. Bonham; two Tora Antelopes (*Alcelaphus tora*) from S. Africa, purchased; two Sœmmerring's Antelopes (*Gazella sœmmerringi*) from S. Africa, deposited; a Crested Pigeon (*Ocyphaps lophotes*), bred in the Gardens.

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, No. 8, 1876.—This interesting number commences with a paper by M. Zöllner, investigating a class of electrical phenomena that do not appear to have been previously studied. When two different bodies, an insulator and a half-conducting rubbing instrument are rubbed together, electrical currents occur in the rubber, as follows:—If the rubbed insulator be positively electric, the currents at the surface of contact or in the interior of the rubber are parallel, but opposite to the relative motion of the insulator; if the latter be negative, the currents of the rubber are parallel, and in the same direction as the insulator's motion. These currents were measured, and shown to be often very considerable, and they could be intensified by multiplying the rubbers and connecting their corresponding parts with wires. They lessen the useful effect of an electric machine, and an advantage is had by uniting the electricity at the positive end of the rubber with the positive electricity of the conductor. M. Zöllner is led to study a variety of related experiments, *e.g.* the currents generated in flow of water through a thin tube. He arrives at this general result: Diaphragm-currents and their modifications are due to the occurrence of new electromotive forces, such that the electric current they generate in the moved liquid, so long as it is in contact with the canals of the diaphragm or the capillary tube, are always opposite to an electric current which would force the liquid in the same direction through the diaphragm as the mechanical pressure.—From experiments made with caoutchouc, carbonic acid, and hydrogen, on the diffusion of gases through absorbing substances, M. Wroblewski concludes that the velocity with which a given quantity of gas diffuses through a caoutchouc membrane is proportional to the pressure of the diffusing gas on the membrane.—A paper on the radiometer is contributed by M. Finkener; the object of the experiments was to show the influence of change of gas, pressure, and radiant heat on the instrument. He finds (1) that with rarefaction not carried too far, and with equal heating, a given motion takes place at a greater pressure in a specifically lighter gas than in a heavier one; (2) the turning force excited by the flame increases at first (other circumstances the same) with the rarefaction of the gas, but with further rarefaction decreases; (3) this maximum occurs at a greater pressure with hydrogen than with air and carbonic acid. M. Finkener offers an explanation of the motion, deduced from these phenomena.—The law of colour-mixture may be studied by superposing different parts of two spectra, or looking at a glass plate from which a surface of one colour is reflected while another colour is seen through it, or by means of the persistence of impressions from a disc with variously coloured sectors or rings set in rapid rotation. M. Bezold here gives another and still more convenient method. You look through a prism of Iceland spar set in a tube blackened interiorly, which is closed below by a disc with four squares cut out of it. The prism gives double images of the squares, and in a certain position two of the eight are brought to coincide with other two in the middle. Surfaces of different colours being brought under the two squares occupying (say) the upper row, their composite colour is obtained in the middle image, and then may be found what colour must be put under the lower two squares to obtain a colour in the middle corresponding to the one above.—Dr. Berthold collects some interesting early indications of a knowledge of the phenomenon of fluorescence as shown by an infusion of nephritic wood. It is remarkable that though Priestley, Fischer, and Wilde referred at some length to the observations made by Kircher, Boyle, Newton, Wolff, and Wunsch, on fluorescence, the facts should have been almost entirely forgotten till our time.—Studying the influence of temperature on the galvanic conductivity of tellurium, M. Exner finds that the seemingly quite irregular resistances of the metal after repeated heatings stand in direct relation to the time of heating and of cooling, a circumstance which must be connected with the crystalline structure of tellurium at low temperatures.—Among the remaining papers we note accounts of an apparatus for combination of vibrations at right angles to each other (Stöhrer), a new hydrometer (Sedlaczek), and an improved poison syphon (Antolik).

Sitzungsberichte der naturwissenschaftlichen Gesellschaft Isis in Dresden, January to June, 1876.—From this publication we note the following papers of importance:—*Mineralogical and Geological Section.*—Geognostical researches on the Leitmeritz mountains, by Herr Engelhardt.—On the Velino fall near Terni, by C. Bley.—On the silver and gold mines in the neighbourhood

of Nertschinsk, by Herr von Pischke.—On the coal formation in the Plauen district, by Dr. Geinitz.—*Section for Researches on Prehistoric Times.*—On the sepulchral mounds (dolmen) of Denmark, by Herr Jünger.—On some objects found recently in former Lake dwellings, by Herr Geinitz.—On the burying-places of Auvernier on the Neufchatel lake, by Prof. Desor.—On the composition of some mortars and face powders of the ancients, by Dr. Landerer.—On some tablets with interesting inscriptions recently found at Pompeii, by Sig. Fiorelli.—On the occurrence of artificially pointed sticks of wood in a layer of argillaceous coal in Switzerland, by Prof. Ecker.—Report of the last meeting of the German Anthropological Society at Munich, and remarks on the same, by Major Schuster.—*Zoological Section.*—On the season dimorphism of certain day lepidoptera, by Herr von Kiesenwetter.—On anthropoid monkeys, by Dr. A. B. Meyer.—On the metamorphosis of the Mexican axolotl, by Dr. B. Vetter.—*Physical and Chemical Section.*—On an improved influence electrical machine, by Carl Dathe.—On a new galvanometer, by Schadewell in Dresden, and on a new Geisler radiometer, by Prof. Neubert.—On the action of chloride of lime upon carbon compounds.—*Mathematical Section.*—On ray-complexes of the second degree, by Dr. Burmester.—On methods of projection, by the same.—On the problem to determine two curves, by Dr. Heger.—On the mechanical conception of chemical processes, by Dr. Hoffmann.—On Riemann's planes, by Dr. Koenigsberger.—On the composition of forces in space, by Herr Mohr.—*Botanical Section.*—On cotton at Pompeii and on some Italian botanical gardens, by Carl Bley.—On some new garden and house plants, by G. A. Petzold.—*General Meetings.*—On excavations and discoveries near Halle, by Dr. Caro.—On the Colorado beetle, by Herr von Kiesenwetter.—On the intellectual life of insects, by the same.—On the axioms of mathematics, by Dr. Koenigsberger.—On researches made in the Caucasus Mountains on earth wax, petroleum, and mud volcanoes, by Dr. Schneider.

Zeitschrift für Wissenschaftliche Zoologie, vol. xxvii. Part I.—R. Wiedersheim, of Würzburg, devotes a long paper to an account of the structure, disposition, and secretion of the cephalic skin-glands in the tailed amphibia. They appear to possess very generalised characters, and the author regards them as representing the more specialised Meibomian, Harderian, and other glands of higher animals. He claims to have demonstrated the connection of many of his gland-cells with nerve-fibrils, and with branches of ganglion-cells.—August Weissmann has an elaborate contribution on the Daphnidæ, dealing with the formation of the winter eggs in *Leptodora hyalina*. He describes at length the origin of the winter egg, which at first contains several large nutritive cells destined to have all their contents absorbed by one cell to form the nutritive mass for the young germ. Many interesting details are given; but if everything were written at such length, only Germans would survive.—Dr. William Marshall, of Weimar, who has published valuable researches on the Hexactinellid Sponges, has an article on their classification and relationships. His systematic revision of the genera and species will be very useful. He considers the sponges with four-rayed spicules to have been derived from the Hexactinellids, and finds no sharp distinction between the latter and the Ventriculitidæ.—Franz Vejdovsky, of Prague gives an account of the anatomy of *Tubifex umbellifer* (Ray Lankester), for which he creates a new genus, Psammoryctes. This interesting fresh-water oligochætous annelid has been found in Lake Onega, in Victoria Docks, in the Paris Jardin des Plantes, and in Bohemian lakes.

THE sixth part of Reichert and Du Bois Reymond's *Archiv* for 1875 (issued as late as May last) opens with the conclusion of Du Bois Reymond's second memoir on the negative variation of the muscle-current during contraction; it must necessarily be read by all students of this abstruse subject.—R. Hartmann continues his lengthy contributions to our knowledge of the anthropoid apes, by describing several skulls of chimpanzees.—The remaining papers do not call for notice in these columns.—Part I for 1876 contains an interesting account, by F. Kurtz, of the minute anatomy of the leaf of *Dionæa muscipula*, accompanied by two plates.—A very long paper by Hermann Munk follows, in this and the following part, on the electrical and motor phenomena of the leaf of *Dionæa muscipula*. The views of Dr. Burdon Sanderson and Prof. Hermann are controverted in many respects; it being contended that the resemblance between the contraction of muscle and that of the leaf is far less complete than the former observer has asserted.—Parts I and 2 contain further contributions by Du Bois Reymond on the negative variation of the muscle-current.—Prof. W. Krause maintains his account of the allantois in the human embryo against Kölliker's denial of its existence in his recent work on Development.—Dr. Grüber gives some more notes of minor anatomical variations in the second part, and Dr. Adamkiewicz commences a further contribution on animal heat, which promises to be of great interest.

No. 32 of the *Journal* of the Quekett Club contains the following papers:—On the principle of illumination in connection with Polarisation, by Mr. W. K. Bridgman; On a new method of mounting microscopical objects, by Prof. H. L. Smith; On a new process of histological staining, by Dr. Francis E. Hoggan; On *Tubicolaria Najas*, by Mr. J. Fullagar; the address of the President, Dr. Matthews, and the Eleventh Annual Report.

SOCIETIES AND ACADEMIES

LONDON

Royal Microscopical Society, October 4.—Mr. H. C. Sorby, president, in the chair.—A paper was read by Mr. Thos. Palmer on a new method of measuring and recording bands in spectra, consisting of a photographed micrometer scale shown in contact with the spectra in the field of view and so arranged as to be capable of adjustment as required. The values indicated by the micrometer were by means of a chart and tables engraved and prepared by the author, easily converted into wave-length measurements.—A paper on the microscopical structure of amber, by Mr. H. C. Sorby and Mr. P. J. Butler, was read by the president.—A paper by Dr. Hinds on a curious effect in connection with the cells in the leaves of *Hypericum Androsæmum* was (owing to the lateness of the hour) taken as read.

PARIS

Academy of Sciences, Sept. 25.—Vice-Admiral Paris in the chair. The following papers were read:—Examination of observations presented at various epochs regarding the transits of an intra-Mercurial planet (continued), by M. Leverrier. He notices fourteen observations from 1820 to the present.—Probable consequences of the mechanical theory of heat, by Gen. Favé. The heat from the sun may have a repellent action on the stars. The phenomena of latent heat may probably be explained by supposing that a liquid contains a greater quantity of interposed ether than a solid, and a gas more than a liquid. Tempered steel probably owes its elastic property to an increase of ether. Ozone and oxygen, sulphur and phosphorus, in their different states, perhaps obey the same law. Opaque solid bodies, as well as transparent bodies, have a certain quantity of constituent ether which increases with the temperature.—On the contact of a curve with a system of curves doubly infinite, by Mr. Spottiswoode.—Photomicrographic researches on the effects of reduction of salts of silver in photographic negatives, by M. Girard. Examining with high power a negative developed indistinctly with sulphate of iron or pyrogallic acid, there are found in the clear unimpressed parts, crystals of reduced iodide of silver uniformly distributed; these constitute the *veil*, a cause of frequent insuccess.—The carburetted schists of Côtes-du-Nord, by M. Hena.—On the destruction of phylloxera by intercalary cultivation of red maize, by M. Gachez. The insect abandons the vine to attack the roots of the maize.—On the use of bobbins of very small resistance in employment of telegraph lines for meteorological announcements in stormy weather, by M. Germain.—On the number of branches of curves of a system (μ, ν), which cut a given algebraic curve at an angle of given magnitude, or the bisectrices of which have a given direction, by M. Fouret.—New process of extraction of gallium, by M. Lecoq de Boisbaudran. The gelatinous precipitate given by zinc in the acid solution of the natural mineral is dissolved in hydrochloric acid and treated with sulphuretted hydrogen. Carbonate of soda added in portions to the filtered liquid, enables the oxides with which the gallium is associated to be isolated. These transformed into sulphates, leave in hot water the sub-salt of gallium when the oxide of this metal is precipitated by a prolonged current of carbonic acid. It has then only to be purified.

October 2.—Vice-Admiral Paris in the chair. The following papers were read:—Rectification of an error which mars theorems on systems of two or three segments, making a constant product, by M. Chasles.—Intra-Mercurial planets (continued), by M. Leverrier. He analyses the observations given. We possess data for a first theory which will make it possible to find the planet easily,

and bring it into the regular planetary system. There will not be a transit in September and October for several years.—Note on the transits of hypothetical intra-Mercurial bodies over the sun, by M. Janssen [See separate article].—Industrial application of solar heat, by M. Mouchot. He presented a small solar alembic, with mirror 58 cm. diameter. The boiler contains one litre of wine which boils after half an hour in the sun. The vapour passes in a tube through the bottom of the mirror to the worm where it is condensed. With water in the boiler, and a receptacle for odoriferous leaves or flowers interposed between it and the worm, various essences may be distilled; or the steam may be used to cook vegetables.—Note on Phylloxera, by M. Lichtenstein.—On the theory of solar spots and the constitution of the sun, by M. Gazan. The spots he explains by continuous cooling of the sun, which changes the inferior layers of vapour of its atmosphere into liquid layers. The sun is a large earth, with nucleus in fusion, vapour and gases in a solid envelope, surmounted by a luminous liquid layer, and supporting an atmosphere of vapour and gas.—Discovery of the planet 168; telegram on September 28, by Mr. Joseph Henry, of Washington, to M. Leverrier. Discovered by Mr. Watson at Ann-Arbor.—Discovery of the planet 169 by M. Prosper Henry, by M. Leverrier.—Elements and ephemerides of the planet 164 Eva, by M. Bossert.—Influence of temperature on magnetisation, by M. Gaugain. If a steel bar, with one end in contact with a magnet, be several times heated and cooled between temperatures T and t, the corresponding magnetisms M and m assume variable values. The ratio $\frac{M-m}{m}$ expresses the value of this *temporary variation*. This coefficient increases considerably the further you go from the point of contact. The ratio $\frac{M-M_0}{M_0}$ expresses the value of the *permanent variation*; M_0 being the magnetisation at ordinary temperature at a given point, before heating, and M that obtained after a series of heatings. This coefficient also increases with distance from the point of contact, and more rapidly. The coefficient of temporary variation is independent (within certain limits) of the intensity of the magnetising force, that of permanent variation increases as the force diminishes.—Chemical reactions of gallium, by M. Lecoq de Boisbaudran.—On a skeleton of Hemiphractus, by M. Brocchi.—On the nature of the phenomena of cell division, by M. Fol. These are studied in Heteropoda, Sea Urchins, and Sagitta. They are occasioned by a fusion between the protoplasm and the nucleus, beginning at the two opposite poles of the nucleus. When reproduction commences the nucleus ceases to be the centre of the system, and the points of fusion become places of convergence for the currents of sarcode which run on all sides towards these new masses. The new nuclei result from partial liquefaction of these masses. They are then composed of a mixture of the substance of the old nucleus and the protoplasm of the cell.—Siphonation and migration of gases, by M. Bellamy. He describes several phenomena that may be distinguished from osmose proper (through a septum), in which there are conductors of large surface and length almost *nil*, while here the conductor has a narrow surface and a relatively great length.

GENEVA

Society of Physics and Natural History, August 3.—Prof. J. L. Soret gave an account of the results of a new series of researches in which he is engaged along with M. Edward Sarasin, on the rotatory polarisation of quartz, principally for the ultra-violet rays, to which these measurements have not been before extended. By means of Broch's method and by employing for this purpose the spectroscope with fluorescent eye-piece devised by M. Soret, a prism of spar and quartz lenses, they have carried their measurements as far as the line R. They have repeated, besides, a great number of determinations for the different lines of Fraunhofer in the visible part of the spectrum. Their results agree in a satisfactory manner for that part with those of the physicists who have preceded them. Moreover, they have found a striking agreement between their results as a whole from A to R and those which result from the formula given by M. Boltzmann for connecting the rotatory power with the wave-length.

VIENNA

Imperial Academy of Sciences, July 20.—The following, among other papers, were read:—Annual period of the insect fauna of Austria and Hungary; II., the beetles (*Coleoptera*), by M. Fritsch. This is in two parts, the first treating of times of appearance (observation of 5,025 species at sixty-five stations from 1852 to 1874); the second, of annual distribution.—On the vessel-nerves of the Ischiodon, by M. Stricker.—A contribution on the action of the heart, by M. Rokitansky. This refers to the action of richly-oxygenated so-called apnœic blood in the arteries and veins on the heart.—Microscopic studies on growth and change of hair, by M. Ebner. He shows that the inner root sheath is essential for hair formation, and though broken through by the hair, it grows during the whole hair-vegetation, in the lower part of the follicle with even greater rapidity than the hair. He defends Langer's view that the new hairs are formed in the old follicle and on the old papilla, and describes fully the mechanism of the process.—Researches on the influence of light and radiant heat on the transpiration of plants, by M. Wiesner. Both luminous rays and dark heat rays strengthen transpiration. Ultraviolet rays have probably little action of this kind. With a gas flame, the influence of the dark heat on transpiration is relatively more prominent than with sunlight (in the one case, *e.g.*, 57 per cent. of the action was due to the dark heat rays; in the other, 21 per cent.). The increase of transpiration of green plants through light is due to absorption of the light by the chlorophyll, and transformation of it into heat, whereby the tension of water vapour in the gas-spaces of the plant is increased, and so the relative moisture, and there is an escape of aqueous vapour into the atmosphere. Other colouring substances, such as etiolin, favour transpiration like chlorophyll by their power of changing light into heat, but in less degree.—Contributions to anatomy and morphology of the bud coverings of dicotyledonous woody plants, by M. Wiesner.—On the consequences of action of temperature on germination and germinating power of the seeds of *Pinus picea*, Du Roi, by M. Velten. The percentage and rapidity of germination warrants no sure inference as to germinating power of seeds. Heating of seeds may have a favourable or an unfavourable influence on the germinating power, according to the physiological state in which the seed is. The duration of the heating has an important influence on development of seeds, inasmuch as long heating at low temperatures can produce the same effect as short heating at high temperatures.—On the theory of waterspouts, by M. Boué. He opposes Faye's view that these are always formed from below downwards. He has witnessed some formed the other way.—M. Viktor v. Lang described an improvement on M. Broch's method of determining the rotation of the plane of polarisation by quartz.—On barometric measurement of heights, by M. Hann. This refers chiefly to influence of moisture on the results of such measurement, and shows how to take exact account of it where measurements of moisture are wanting, at the two stations whose difference of level is to be ascertained. He calculates from the observed air-temperature and an estimated *relative* moisture.—On the velocity of propagation of sound-waves from explosions, by MM. Mach and Sommer. The experiments show that this velocity rapidly increases with the violence and suddenness of the explosion.

CONTENTS

ERRATUM.—Vol. xiv. p. 506, col. 1, line 17 from top, for *applied, a coast*, read *applied to a coast*.

THURSDAY, OCTOBER 19, 1876

MAUDSLEY'S "PHYSIOLOGY OF MIND"

The Physiology of Mind. Being the First Part of a Third Edition, Revised, Enlarged, and in great part Re-written, of "The Physiology and Pathology of Mind." By Henry Maudsley, M.D. (London: Macmillan and Co., 1876.)

MAN very long ago, probably about the time he became man, reflected that he felt and thought; since then no one has ever had the least doubt, as to whether a given object of thought was a fact of mind or of body; and every attempt to resolve the one into the other has been but the vain enterprise of a misguided intelligence. The physical and mental stand over against each other—the fundamental duality of being which no effort of thought has been able to transcend. How, after reflecting that they felt, our far-off ancestors came to refer their feelings and reflections to a soul or spiritual entity, which they supposed to inhabit and animate the body, to cause and direct its movements, can never be more than a subject of speculation. But that such was the universal belief of mankind, that such is still the creed of all save a few, and that all language has been evolved under this conception, scarcely requires to be stated. For ages the curious speculated around the fascinating mystery of the union of soul and body—and yet the mystery remained. A slow change of view, however, was taking place. From the belief that the life and movement, the health and disease of the body, were in some way directly dependent on a conscious, thinking soul, we have passed gradually, very gradually, to the view held by that body of thinkers who claim to be the scientific psychologists of the present day, which is, that mind, feeling, and thought, in a word, consciousness, is dependent on bodily organisation. Dr. Maudsley presents the volume before us as a treatise or "disquisition, by the light of existing knowledge, concerning the nervous structures and functions which are the probable physical foundations, or the objective aspects of, those natural phenomena which appear in consciousness as feelings and thoughts, and are known only in that way."

Ten years ago, when Dr. Maudsley published the first edition of his work, "The Physiology and Pathology of Mind," of which the volume before us is the first part much enlarged, there was a need, which no longer exists, for iterating and reiterating the evidence of the invariable and uniform connection of mental phenomena with nervous organisation. This useful work Dr. Maudsley did well, and as he himself says, "with all the vehemence of youthful enthusiasm." The dependence of consciousness on nervous organisation may be claimed as fairly established, and the great question that now presses on the attention of the scientific psychologist is, What mode of connection can we figure to ourselves as the relation subsisting between consciousness and the material organism? We are among those who maintain that to this problem no acceptable solution has yet been proposed. Dr. Maudsley thinks otherwise, and much of the present volume is taken up with attempts to unveil this deepest of nature's mysteries. We have come to believe, taking it as established, that for a given fact of nervous action the corresponding fact of consciousness will ever be the same. The question now is, in what relation does this fact of consciousness stand to the constantly related, but totally unlike, phenomena which we describe as nervous action? The phenomena, it is answered, are not so totally unlike. "Above all things it is now necessary," says Dr. Maudsley, "that the absolute and unholy barrier set up between psychical and physical nature be broken down, and that a just conception (of mind) be formed, founded on a faithful recognition of all those phenomena of nature which lead, by imperceptible gradations, up to this its highest evolution." (We continue the quotation simply as illustrating Dr. Maudsley's style, which we venture to think is still at times rather above the sober unimpassioned language of science.) "Happily, the beneficial change is being gradually effected, and ignorant prejudice or offended self-love in vain opposes a progress in knowledge which reflects the course of progress in nature; the stars in their courses fight for such truth, and its angry adversary might as well hope to blow out with his pernicious breath the all-inspiring light of the sun as to extinguish its ever-waxing splendour." Well, the unholy barrier between psychical and physical nature has to be broken down, and to this end we are called on to form a conception of mind which will enable us to conceive it as a product of physical evolution. Complete failure has, we think, been the reward of every one who has ventured on this most hopeless undertaking (see our article "Cosmic Philosophy," NATURE, August 5, 1875). Let us see, however, how Dr. Maudsley would have us proceed. In the first place, we are invited to perceive distinctly "that consciousness is not co-extensive with mind, that it is not mind but an incidental accompaniment of mind." This is certainly a large demand to begin with, and we would rather be with those who would maintain "that it is improper and indeed absurd to speak of mind except when speaking of states of consciousness." The word "mind" has been used by all mankind to denote states of consciousness, and not a material organism, nor the changes in an organism. The philosophers also are against Dr. Maudsley, but of these he makes little account. We may notice in passing, however, that, in preparing for criticism Prof. Bain's statement that mind is "the sum total of subject experiences, that which has not extension," he finds it convenient to "alter the wording of it" so as to make it "run thus—mind is the sum total of the experiences of that which has not extension, *that which has not extension being a subject!*" We can only suppose that Dr. Maudsley has wholly misunderstood Prof. Bain's words. Prof. Bain, as we understand him, means to give a double description of mind—it is the sum total of subject experiences, or again, it *is* that which has not extension. The difference between this and the statement—mind is the sum total of the experiences of that which has not extension—is obvious.

But to proceed. By insisting that "emotions good or bad are physical phenomena," "that ideas are insensible motions of nerve-molecules, of the nature of vibrations," Dr. Maudsley can without much further violence to

language bring the relation of mind to the physical organism under the familiar conception of organ and function.

Cabanis spoke of the brain secreting thought as the liver secretes bile. Dr. Maudsley recognises, however, that this is a "fallacious comparison." "Here," he says, "as elsewhere, confusion is bred by the common use of the word secretion to express, not only the functional process but the secreted product, both the insensible vital changes and the tangible results of them." It seems, then, that by the word "mind" Dr. Maudsley really means to denote certain vital changes of the brain and nerves; when he speaks of an emotion or an idea, he means to refer to certain peculiar agitations of the white and gray matter of the nervous system. There is no difficulty now in seizing Dr. Maudsley's meaning when he speaks of "the performance of an idea," nor in conceiving "mind," that is, the nervous operations, as the functions of the nervous system. And we have no other criticism to make than is implied in the remark that Dr. Maudsley by using language in this way would not, we fear, commend himself to the old woman who was all her life so thankful that Adam had had the good sense to call all the animals by their right names.

Accepting Dr. Maudsley's nomenclature we have not the slightest difficulty in conceiving "that all the operations which are considered mental and to belong to psychology, may be performed as pure functions of the nervous system, without consciousness giving evidence of them, or having any part in them;" on the contrary we are, as will presently appear, disposed to be more thorough than Dr. Maudsley himself in regarding the physical machine as sufficient for all its own operations. But before proceeding to this the second branch of our criticism, let us recall the original, in fact, the only difficulty. Are we, now that we can talk of the "physiological mechanism" working out the "cognition of a logical necessity without the aid of consciousness"—are we in a better position to figure to ourselves the mode of connection between consciousness, this mere "satellite of mind," and those physiological operations? The darkness remains thick and impenetrable as ever. Here are some of the empty, worse than empty, phrases, with which Dr. Maudsley would have us conceal the limits of our intelligence, and our blank ignorance of what lies beyond these limits. "Consciousness," he says, "is a quality or attribute of the concrete mental act." It is, however, we may be permitted to think, a most singular quality of physiological operations—we must not forget that these are our mental facts—for it has, like Lucifer of old, rebelled against the supreme power, having, as Dr. Maudsley complains, "miraculously got rid of its substance, and then with a wonderful assurance assumed the office of commenting and passing judgment from a higher region of being, upon the nature of that whereof it is actually a function." Consciousness, then, is a function, an attribute, a satellite, a quality, the usual but "not the indispensable accompaniment of mental function." To ask *why* "cerebral organisation functions as conscious energy?" is, says Dr. Maudsley, "an unwarrantable demand." It would probably be so; what is asked of men of science is not *why?* but *how?* How are we to manipulate our conceptions of matter and motion, so as to get out of them our conception of consciousness? The thing is not to be done.

We come now to the second branch of our criticism. Strange to say, after preaching the gospel of Matter and "the wonderful works which it is continually doing before our eyes," Dr. Maudsley finds himself as helpless as the most bewildered of the metaphysicians, whom he holds in such supreme contempt, to work the animal machine without the assistance of something that is not physical. In arguing against the presence of consciousness in the performances of the decapitated frog, Dr. Maudsley contends that consciousness is not required for the performance of these movements, that they "may be explained satisfactorily without the assumption that its spinal chord possesses feeling and will," "that the frog acts necessarily and blindly." In thus contending for the "mechanical," "the entirely physical nature of the movements," Dr. Maudsley would distinguish them from another class of actions which he recognises as not entirely physical in their nature, as somehow "dependent on consciousness," not blind and necessary, but "instigated by will and guided by intelligence." Surely it is to little purpose that Dr. Maudsley has made thought and emotion physical phenomena, if he must after all call in the aid of consciousness of something not physical, to work the mechanism of a frog. This is not, as might be supposed, a mere slip in a subordinate argument. The thraldom of spiritualism, from which Dr. Maudsley has not escaped, betrays itself in all parts of his book, even when he is deliberately straining after his favourite conception of a thinking machine. "It may seem," he says, "an extravagant thing to say, but to me it seems conceivable that a man might be as good a reasoning machine without as he is with consciousness, if we assumed his nervous system to be equally susceptible to the influences which now affect him consciously, and if we had the means, by microscope or galvanoscope or some other more delicate instrument hereafter to be invented, of reading off the results of his cerebral operations from without." Why does Dr. Maudsley need to call in the aid of microscope or galvanoscope, or some other more delicate instrument? Why should his unconscious man, equally susceptible to the influences which now affect him consciously, not be able when asked to tell us the results of his deliberations, or to write them down for us? Is it that after the sound waves of our question have agitated the tympanum and set the appropriate nervous mechanism in motion, these physical phenomena have to be translated into, or taken note of, by consciousness—by something that is not mechanism, or that is at least *more* than the working of mechanism—in order that this nervous stimulation from without should give rise to the movements implied in speaking or writing? Dr. Maudsley's unconscious reasoner who cannot tell us the results of his reasoning is a defective construction. In spite of himself Dr. Maudsley gives to consciousness, to "the witness," "the sense by which the (reasoning) operations are observed within," exactly the mysterious place and inconceivable functions which less advanced people attribute to the thinking soul, which they believe to inhabit the body to cause and direct its movements.

Our space requires that we should bring our criticism to an end; nor is there much occasion to carry it further

We shall therefore conclude with a remark on Dr. Maudsley's attempt to make something of the will—that apparent point of contact of the physical and the mental, which has been the veritable will-o'-the-wisp of our psychologists. Towards the end of his book (p. 442) Dr. Maudsley, in examining a "simplest case of volition," tells us that it "sprang from that fundamental property of organic element by which what is agreeable is sought, what is painful is shunned." This is not advancing knowledge, but rather the reverse. How can any substance, whether we call it organic element or by any other name, seek the agreeable and shun the painful? By movements; we know of no other way of seeking and shunning. But how are these mental things, pain and pleasure, related to movements of any kind? Here we find ourselves, after much laborious groping, face to face with the very problem we set out to solve. Truly what we have to learn in psychology, before and above all things, is our ignorance.

DOUGLAS A. SPALDING

OUR BOOK SHELF

Annual Record of Science and Industry for 1875. Edited by Spencer F. Baird, with the assistance of eminent men of science. (London: Trübner and Co., 1876.)

FOR this admirable record we have again to thank our American friends. The volume now extends to some 900 pages, and each year brings improvement as well as enlargement of its contents. Unfortunately so many subjects are now embraced within the scope of this annual record, that the space devoted to each subject is necessarily curtailed. This, we think, is a misfortune. If feasible, we would venture to suggest a division of the record into two parts, inasmuch as pure, applied and very homely science are here in close and curious juxtaposition. Thus we find "tables of elliptic integrals," the "computation of the areas of irregular figures," or the "dissipation of energy," followed by "beautiful ornament for rooms," "renewing wrinkled silk," and "improved modes of closing barrel hoops." It is true the editor has most carefully and laboriously classified the whole, so that we are gradually let down from elliptic integrals at the beginning to barrel hoops at the end. Doubtless the editor considered that by these things men would learn "beer and skittles" was an integral part of the scientific as well as the popular need. The first half of the work, which gives a general summary of scientific and industrial progress for the past year, is more carefully edited than the brief notices of papers which form the second half. For example, turning to general physics, we find paragraphs on Mr. Crookes' experiments scattered about in several places; the same is true of Dr. Guthrie's researches on cryohydrates and of several others we might name. Again, in the index, which is extremely minute, the same name is put under different headings; thus, Mr., Mr. Frederick, and Prof. Guthrie are the same person, though separately referred to. But in spite of these criticisms, the book is a useful one and contains a vast mass of information. Sketchy as it is, nevertheless it is undoubtedly the best annual record of science—in fact the only one in the English language; and hence we are glad to observe that a suggestion we made in noticing the preceding volume, namely, having a London as well as a New York publisher, has now been carried out. The scientific bibliography of the year and the references to periodicals, giving the fullest reviews of the books themselves, is an excellent and valuable feature of this Record.

Causeries Scientifiques. J. Rothschild, Editeur. (Paris.)

THIS little book gives a brief and popular account of some of the principal discoveries and inventions of the past year. It is written in a lively, simple style, and doubtless has done something in France to extend an interest in science and to spread a knowledge, though but a superficial one, of the more striking results of experimental research. The absence of technical terms brings the volume before us within the comprehension of those who have had no scientific education. How is it we are so behind our neighbours in books of this kind? It would, however, have been well if the editor of this volume had paid a little more attention to the spelling of English names, and exercised closer supervision throughout, as we notice several misprints in its pages.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Self-fertilisation of Plants

SOME years ago my suspicions were strongly aroused by certain observations, against the importance of intercrossing; and since then other conclusions, such as the following, have been steadily forcing themselves upon me, and which will probably agree with Mr. T. Meehan's: (1) that self-fertilisation was the primordial condition of plants; (2) that conspicuous flowers of all kinds are a secondary result, due to insect agency, by increasing the size, &c., of the perianth; (3) that this has, in its turn, caused a correlative disturbance in the sexual arrangements, viz., that it has caused to be sacrificed the (originally) normal state of self-fertilisation, and has set up cross-fertilisation instead; (4) that this latter being relatively less certain of being effected, is *compensated* for by a superabundance of pollen, alteration in its form and influence, dimorphism, the separation of sexes, and perhaps other details of sexual differentiation; (5) that the existing self-fertilising flowers are in no case primordial but degraded forms; (6) that in consequence of such degradation, of the perianth especially, the sexual organs have recovered their original energies, and so resume their long lost self-fertilising powers.

The *rationale* of the whole process I take to be "compensation." In the first instance, the enlargement of the corolla is accompanied either by a more or less degree of destruction of one or both of the sexual organs; as in the ray-florets of *Centaurea*, which are neuter; in "double" flowered compositæ, where the new "ligulate" ones pass from the usually hermaphrodite condition of the tubular disk florets, or male, as in *Calendula*, to female only, or even to the neuter state, as in Dahlia; or else by the above-mentioned differentiations of the sexual organs in their forms and functions. The primary cause of such increase in the perianth may, perhaps, be due to the mere mechanical influence of the insects themselves, which by constantly renewed pressure, may determine a flow of nutriment to those parts; this—which I only assume as probable—diverts it temporarily from one or both whorls of essential organs. The result is protandry or protogyny, &c. To compensate again for the loss of self-fertilisation, there come into play, as stated above, all the adaptations to *secure* inter-crossing. Hence the idea of plants abhorring inter-breeding appears to have arisen from observing conspicuous flowers only, and as these are in the majority nowadays, it was a reasonable conclusion: but the self-fertilising ones are extremely numerous altogether; and it is this small but highly significant minority, not to add the special contrivances which occur in order to secure self-fertilisation, which leads one to the opposite conclusion.

Self-fertilisation I believe not to be always an absolute but a purely relative condition; that although many species are now altogether self-fertilising, yet whenever conspicuous flowers become dwarfed, I suspect there is a tendency to their becoming self-fertilising. I have found it to be so in some cases, and should feel extremely glad if any readers of NATURE would kindly observe, at this season of the year especially, whether any dwarfed wild or other flowers they can find are self-fertilising or not, or else be good enough to forward the same to me. For example, I have, this September, found dwarfed blossoms of *Linaria vulgaris* often spurless and without honey, having the stigma situated between the two pairs of anthers, and the pollen-tubes pouring into it both from above and below. Similarly in small flowered

specimens of *Potentilla reptans*, less than half an inch in diameter, and even in unexpanded buds, were the pollen-tubes penetrating the stigmas.

I call attention to pollen-tubes, because, unless they be observed, one cannot feel absolutely certain that the flowers are really self-fertilised; and even then, that fact must be associated with the relative positions of anthers and stigmas, and the resulting *abundance of fruit*.

Another point I would mention of importance is the necessity of observing *the order of emergence of the whorls*. The subsequent rates of growth may prove a source of deception, so that it is necessary to go back to the very earliest condition when the parts are little more than papillæ, and if possible even before one or more of the whorls have put in an appearance at all. Now I find that in conspicuous flowers, with certain exceptions, the corolla is very often the *last* to emerge, though ultimately it attains by far the largest size when adult; that the stamens usually come directly after the calyx, which, if present, is *always* first, acting as a protecting and nourishing organ; and that the pistil comes next. Such an order results usually in protandry; but while conspicuous species, as *Stellaria Holostea*, and *Cardamine pratensis*, have the order, calyx, stamens, pistil, corolla, inconspicuous self-fertilising species are often as follows:- *e.g.*, *Cerastium glomeratum*—calyx, pistil, stamens, corolla, and *Nasturtium officinale*, calyx, stamens and pistil (together), corolla. These examples, out of many collected, appear to point to an important connection between the order of emergence and development on the one hand, and cross and self-fertilisation on the other. The connection between these two orders of facts I take to be, as already stated, due to the fact that the energy of conspicuous flowers is diverted into the corolla, which thereby delays the development of the pistil; but when the corolla is arrested, the pistil recovers itself, and its growth is equal to or precedes that of the stamens, the result issuing in a synchronous maturity, and consequently self-pollination. GEORGE HENSLOW

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Wallace's "Geographical Distribution of Animals"

ALLOW me to point out in NATURE a few errors which occur in Mr. Wallace's "Distribution of Animals," regarding the extinct mammalian fauna of India.

In the first place, there is a mistake regarding the locality of the Perim Island (vol. i., p. 362, vol. ii., pp. 157 and 221), from which Tertiary fossils have been obtained; in Mr. Wallace's book the Perim Island, at the entrance to the Red Sea, is the one referred to, whereas the true spot is Perim Island, in the Gulf of Cambay.

There is, therefore at present no known spot to the eastward of India which shows the former extension of its Tertiary mammalia into Africa and Europe, although such extension doubtless existed.

The extinct genus Enhydriodon, from the Siwaliks (*e.g.* vol. ii., p. 200), is always referred to as Enhydrion.

In vol. i. (p. 122) the genus Tapirus is mentioned as occurring in the Miocene of the Punjab; this determination is on the authority of Dr. Falconer, who hastily examined a single tooth (now in the Indian Museum); this tooth, and others subsequently found, turns out to belong to the European Miocene genus Listriodon; the only other mentioned occurrence of a fossil Tapir in India, is by Mr. Clift, who figured the symphysis of a mandible (*Geol. Trans.*, sec. ser., vol. ii.) from Burma; this may, however, also belong to Listriodon.

In vol. ii. (p. 202) the genus Ursus is mentioned as having been described from the Siwaliks and the Nerbudda Valley; it has only been described from the latter locality, Hyænactos being the Siwalik genus. A new species of tame Ursus has, however, been obtained this year from the Siwaliks, and will be subsequently described.

In vol. ii. (p. 212) Hipparion should also be mentioned as having been found in India as well as in Europe.

At p. 228 of the same volume, it is stated that Elephas has "perhaps one species Pliocene in Central India;" in reality there are two species undoubtedly from the Newer Pliocene of the Nerbudda Valley, viz., *E. nomadicus* and *E.* (Stegodon) *insignis*.

Vol. ii., p. 240, the genus Hystrix has been fossil in the Siwaliks of India as well as in Europe and America.

I may add that, as announced in the August number of the "Records of the Geological Survey of India," for the present year, I have determined the existence of a species of Manis (the first fossil species of the genus) and of a Cetacean, with other new forms, from the Siwaliks. RICHARD LYDEKKER,

Calcutta, August 27 Geological Survey of India

The Resistance of the Electric Arc

FOR the purpose of determining theoretically the best arrangement of cells for the production of the electric light, it was necessary to know the resistance of the electric arc. Not being acquainted with any source from which this information could be derived, we determined this resistance experimentally in two distinct ways.

1. The current from sixty new Grove's cells joined in series (and of which the immersed part of each platinum plate was about 13 square inches in area and of each zinc plate about 25 square inches) was used to produce an electric light with a Duboscq's lamp, when a small known resistance consisting of many metres of thick bare copper wire hanging in the air was also introduced in circuit. This wire was sufficiently thick for its resistance not to be sensibly altered by the passage of the current. The difference of potentials between the carbons was measured with a Thomson's quadrant electrometer, using the induction plate and compared with the difference of potentials between the two ends of the wire of known resistance. These two measurements were made rapidly one after the other and repeated very many times. Then since at any moment the same current is flowing through the electric arc and the wire, the two differences of potentials measured rapidly one after the other are proportional to the resistances.

The above method showed that the resistance of the electric arc varied considerably even when the light appeared quite steady, that the resistance was never more than 20 ohms, and had an average value of about 12 ohms.

2. On another occasion the current from eighty similar Grove's cells joined in series, which had been joined up for three hours, and used at intervals during this time for the production of the light, was sent through the coils of a differential galvanometer. In one circuit was a very high resistance and in the other the electric arc; each coil of the differential galvanometer was shunted with a wire of small resistance. Nearly the whole current, therefore, went through the arc. The shunts being properly adjusted to obtain balance, the resistance of the arc, as in the previous case, was found to vary much but never to exceed 29 ohms and to equal about 20 ohms when the light was best.

That the resistance would be larger than in the previous case was to be expected since the battery contained more cells, and a brighter light would, therefore, be obtained with the carbon points further apart.

At a convenient opportunity we hope to take time readings of the resistance together with photographs of the light on a revolving band of sensitive paper in order to determine the exact resistance corresponding with the brightest light for any particular number of cells.

The results, however, given above show that with cells such as we used, and which are the common Grove's cells employed in England, no attempt should be made to join any of the cells in parallel circuit until at least 200 have been joined in series, for since the resistance of each cell is about 0·2 ohms, 200 of them would have a resistance of 40 ohms, a resistance certainly less than *double* the electric arc for that battery corresponding with brightest light, and we have shown (*Telegraphic Journal*, March 15, 1873) that the cells of a battery should be joined in series until the battery of resistance is *double* the external resistance, at which point the battery should be joined in two rows each containing half the whole number of cells in series, and the two rows connected in parallel circuit. W. E. AYRTON

The Imperial College of Engineering, JOHN PERRY

Tokio, Japan

Habits of Animals Transmitted to Offspring

BREEDING many horses yearly on my station, I notice, as a matter of course, some of their peculiar habits. In a semi-wild state on a run horses graze together in large or small companies, which "station hands" call "mobs;" these mobs wander at will over a large area of country, finding abundance of good natural pasture and water. Some years since a mare became solitary in her habits, always seeking one particular creek; whenever released from work she made off to her favourite feeding ground by herself; if "rounded up with a mob" she would take the earliest chance that presented itself of reaching

her usual haunt. One of her progeny some years after showed a similar liking for solitude; he was placed among several other horses (many of them he had known for years) on a small run intersected with bushy gullies, more or less rocky. He was soon missing, and search was made for him for some time without success; he was supposed to have come to grief in the bush; at length he was found, most unexpectedly, on a small patch of pasture between two rocky gullies thickly bushed; this spot was so difficult of access that a slight track had to be cut to get the horse back. Having been brought from a large station where he was bred and reared, he no longer enjoyed a great range by which he could place any long distance between his companions and himself; he displayed much tact and judgment in the way he secured the indulgence of hereditary habit, by discovering and reaching with difficulty an almost inaccessible solitude. One of the best and fleetest stock mares for the fast and hard work of "cutting out"[1] was a beautiful creature notorious as an incorrigible kicker; she has most faithfully transmitted this vice to her offspring.

Peculiarity in the formation of the hoof has been handed down to descent after descent by a grand old mare who had this blemish as a slight counterpoise perhaps to her many virtues.

A particular strain of Dorking fowls, which I have had for thirty years or so, always shows a restless desire for rambling, and that too under the difficulty of meeting with much persecution when straying beyond their ample range. This special family always exhibits what may be termed the gift of locality.

Ohinitahi, N.Z. THOMAS H. POTTS

Moon-Stroke

THERE is a popular belief that it is dangerous to sleep in full moonshine, as it is supposed to produce some injurious effect called moon-stroke. I have little doubt that the popular belief is well founded as far as the injury to some of those who have slept out at night is concerned, especially in full moonshine; nevertheless the injury is not, I think, due to the moon, but to another cause, which I shall here attempt to explain. It has often been observed that when the moon is full, or near its full time, there are rarely any clouds about, and if there be clouds before the full moon rises they are soon dissipated, and therefore a perfectly clear sky, with a bright full moon, is frequently observed.

A clear sky admits of rapid radiation of heat from the surface of the earth, and any person exposed to such radiation is sure to be chilled by rapid loss of heat. There is reason to believe that, under the circumstances, paralysis of one side of the face is sometimes likely to occur from chill, as one side of the face is more likely to be exposed to rapid radiation, and consequent loss of its heat. This chill is more likely to occur when the sky is perfectly clear.

I have often slept in the open in India on a clear summer night, when there was no moon, and although the first part of the night may have been hot, yet, towards 2 or 3 o'clock in the morning, the chill has been so great that I have often been awakened by an ache in my forehead, which I as often have counteracted by wrapping a handkerchief round my head and drawing the blanket over my face. As the chill is likely to be greatest on a very clear night, and the clearest nights are likely to be those on which there is a bright moonshine, it is very possible that neuralgia, paralysis, or other similar injury, caused by sleeping in the open, has been attributed to the moon, when the proximate cause may really have been the *chill*, and the moon only a remote cause acting by dissipating the clouds and haze (if it do so), and leaving a perfectly clear sky for the play of radiation into space. E. BONAVIA

Lucknow, August 26

The Memoirs of the Geological Survey

I DESIRE through the medium of your columns to call attention to the fact that most of the admirable memoirs of the Geological Survey appear to be out of print. A week or two ago I ordered a number of these publications and was informed that at least half of them are out of print. Prof. Ramsay's "Geology of North Wales" is in this category and the fact is stated in the printed list, but in a letter recently received from the professor he informs me that the work is being reprinted, and is expected to be published about the middle of next year. Without, in the absence of information, desiring to attach blame to any one, I shall be glad to know the reason why works admittedly of the highest value should have been permitted to fall into such apparent neglect. WM. HORSFALL

Manchester, October 9

[1] "Cutting out" is drafting a beast out of a mob, following it through all its wild rushes, twistings, and turnings, through perhaps many hundreds of cattle, never leaving it till it is fairly drafted out. This work often taxes the skill and energy of stockman and his horse pretty severely.

OUR ASTRONOMICAL COLUMN

CHACORNAC'S VARIABLE NEBULA NEAR ζ TAURI.—On October 19, 1855, Chacornac remarked that a star of the eleventh magnitude, north-preceding ζ Tauri, was enveloped in nebulosity, which was sufficiently bright up to the end of January following to occasion surprise that it had not been previously detected. The star had been repeatedly observed in 1854.

Chacornac gives the position of the star upon which the nebula was projected for 1852·0 in R.A. 5h. 28m., 35·6 N.P.D. 68° 52′ 42″. The form of the nebula was nearly rectangular, the longest side subtending an arc of 3½′ and the shorter, one of 2½′. The star occurs in the zone observed at Markree, January 16, 1850, without mention of surrounding nebulosity.

On September 12, 1863, and January 25, 1865, D'Arrest observed the star with the Copenhagen refractor, on the last occasion "cœlo valde eximio," without being able to detect any trace of the nebula. He estimated the star 11·12 m., and noticed another 13 m., about 40″ preceding nearly on the parallel.

From Chacornac's position for 1852, it appears the star precedes ζ Tauri 12·5s., and is N. 4′ 28″. It may be recommended for examination during the approaching winter, particularly with telescopes of moderate dimensions, which in the case of another suspected variable nebula (Schönfeld, 1858) have been shown to possess decided advantage over the larger instruments.

OLBER'S SUPPOSED VARIABLE IN VIRGO.—Mr. Tebbutt of Windsor, N.S.W., communicates the results of some observations of this object and neighbouring stars, made in July and August of the present year. For 1876·0 he found:—

Star.	Magnitude.	R.A. h.	m.	s.	N.P.D. °	′	″
1	7	13	3	7·7	105	51	12
2	9½	13	5	17·6	105	51	15
3	8¼	13	7	32·4	105	53	50
4	9	13	9	12·9	105	37	1

No. 3 is the supposed variable. See this column, 1876, April 13.

RELATIVE BRIGHTNESS OF URANUS AND JUPITER'S SATELLITES.—On the evening of June 5, 1872, M. Prosper Henry, at the Observatory of Paris, took advantage of the very close approach of Uranus to Jupiter (difference of declination only 1′·2 at conjunction) to compare the light of the satellites of Jupiter with the former planet. He found the brightness of Uranus was equal to that of the third satellite, which was nearest to Uranus at the moment. If there existed any difference of light between the two others, it was to the advantage of Uranus, but in any case it was very small. The observations were made with the large Foucault telescope. So favourable an opportunity of making these comparisons may not occur again for a very long period.

BLANPAIN'S COMET, 1819.—A new reduction of the observations of this remarkable comet, taken at Paris, of which we have the particulars in detail, and recalculation of the elements thereupon, appears to lead to a somewhat longer period than was inferred by Encke, from the same observations as at first reduced. This somewhat longer period—a little over five years—would occasion a near approach of the comet to the planet Jupiter at the previous aphelion passage, and it is easy to see that the observations would allow of so close a proximity at this

point of the orbit that a very material change of elements may have been then occasioned, perhaps sufficiently great to account for the difference of the elements from those of the first comet of 1743, which Clausen conjectured to be identical with Blanpain's.

PROF. HUXLEY ON UNIVERSITY EDUCATION[1]

THE actual work of the University founded in this city by the well-considered munificence of Johns Hopkins commences to-morrow, and among the many marks of confidence and good-will which have been bestowed upon me in the United States, there is none which I value more highly than that conferred by the authorities of the University when they invited me to deliver an address on such an occasion.

For the event which has brought us together is, in many respects, unique. A vast property is handed over to an administrative body, hampered by no conditions save these :—That the principal shall not be employed in building; that the funds shall be appropriated in equal proportions to the promotion of natural knowledge, and to the alleviation of the bodily sufferings of mankind; and, finally, that neither political nor ecclesiastical sectarianism shall be permitted to disturb the impartial distribution of the testator's benefactions.

In my experience of life a truth which sounds very much like a paradox has often asserted itself, viz., that a man's worst difficulties begin when he is able to do as he likes. So long as a man is struggling with obstacles he has an excuse for failure or shortcoming; but when fortune removes them all and gives him the power of doing as he thinks best, then comes the time of trial. There is but one right, and the possibilities of wrong are infinite. I doubt not that the trustees of the Johns Hopkins University felt the full force of this truth when they entered on the administration of their trust a year and a half ago; and I can but admire the activity and resolution which have enabled them, aided by the able president whom they have selected, to lay down the great outlines of their plan, and carry it thus far into execution. It is impossible to study that plan without perceiving that great care, forethought, and sagacity, have been bestowed upon it, and that it demands the most respectful consideration. I have been endeavouring to ascertain how far the principles which underlie it are in accordance with those which have been established in my own mind by much and long-continued thought upon educational questions. Permit me to place before you the result of my reflections.

Under one aspect, a university is a particular kind of educational institution, and the views which we may take of the proper nature of a university are corollaries from those which we hold respecting education in general. I think it must be admitted that the school should prepare for the university, and that the university should crown the edifice, the foundations of which are laid in the school. University education should not be something distinct from elementary education, but should be the natural outgrowth and development of the latter. Now I have a very clear conviction as to what elementary education ought to be; what it really may be when properly organised, and what I think it will be before many years have passed over our heads in England and in America. Such education should enable an average boy of fifteen or sixteen to read and write his own language with ease and accuracy, and with a sense of literary excellence derived from the study of our classic writers; to have a general acquaintance with the history of his own country and with the great laws of social existence; to have acquired the rudiments of the physical and psychological sciences, and a fair knowledge of elementary arithmetic and geometry. He should have obtained an acquaintance with logic rather by example than by precept, while the acquirement of the elements of music and drawing should have been pleasure rather than work.

It may sound strange to many ears if I venture to maintain the proposition that a young person, educated thus far, has had a liberal, though perhaps not a full education. But it seems to me that such training as that to which I have referred may be termed liberal in both the senses in which that word is employed with perfect accuracy. In the first place, it is liberal in breadth. It extends over the whole ground of things to be known and of faculties to be trained, and it gives equal importance to the two great sides of human activity—art and science. In the second place, it is liberal in the sense of being an education fitted for free men; for men to whom every career is open, and from whom their country may demand that they should be fitted to perform the duties of any career. I cannot too strongly impress upon you the fact that with such a primary education as this, and with no more than is to be obtained by building strictly upon its lines, a man of ability may become a great writer or speaker, a statesman, a lawyer, a man of science, painter, sculptor, architect, or musician. That even development of all a man's faculties, which is what properly constitutes culture, may be effected by such an education, while it opens the way for the indefinite strengthening of any special capabilities with which he may be gifted.

In a country like this, where most men have to carve out their own fortunes and devote themselves early to the practical affairs of life, comparatively few can hope to pursue their studies up to or beyond the age of manhood. But it is of vital importance to the welfare of the community that those who are relieved from the need of making a livelihood, and still more, those who are stirred by the divine impulses of intellectual thirst or artistic genius, should be enabled to devote themselves to the higher service of their kind as centres of intelligence, interpreters of nature, or creators of new forms of beauty. And it is the function of a university to furnish such men with the means of becoming that which it is their privilege and duty to be. To this end the university need cover no ground foreign to that occupied by the elementary school. Indeed, it cannot; for the elementary instruction which I have referred to embraces all the kinds of real knowledge and mental activity possible to man. The university can add no new departments of knowledge, can offer no new fields of mental activity; but what it can do is to intensify and specialise the instruction in each department. Thus literature and philology, represented in the elementary school by English alone, in the university will extend over the ancient and modern languages. History, which like charity best begins at home, but, like charity, should not end there, will ramify into archæology, political history and geography, with the history of the growth of the human mind and its products in the shape of philosophy, science, and art. And the university will present to the student libraries, museums of antiquities, collections of coins, and the like which will efficiently subserve these studies. Instruction in the elements of social economy, a most essential, but hitherto sadly-neglected part of elementary education, will develop in the university into political economy, sociology, and law. Physical science will have its great divisions of physical geography, with geology and astronomy; physics, chemistry and biology, represented not merely by professors and their lectures, but by laboratories, in which the students, under guidance of demonstrators, will work out facts for themselves and come into that direct contact with reality which constitutes the fundamental distinction of scientific education. Mathematics will soar into its

[1] Address (revised by the Author) delivered at the formal opening of the Johns Hopkins University at Baltimore, U.S., September 12. The total amount bequeathed by Johns Hopkins is more than 7,000,000 dollars. The sum of 3,500,000 dollars is appropriated to a university, a like sum to a hospital, and the rest to local institutions of education and charity.

highest regions; while the high peaks of philosophy may be scaled by those whose aptitude for abstract thought has been awakened by elementary logic. Finally, schools of pictorial and plastic art, of architecture, and of music should offer a thorough discipline in the principles and practice of art to those in whom lies nascent the rare faculty of æsthetic representation, or the still rarer powers of creative genius.

The primary school and the university are the alpha and omega of education. Whether institutions intermediate between these (so-called secondary schools) should exist, appears to me to be a question of practical convenience. If such schools exist, the important thing is that they should be true intermediaries between the primary school and the university, keeping on the wide track of general culture, and not sacrificing one branch of knowledge for another.

Such appear to me to be the broad outlines of the relations which the university, regarded as a place of education, ought to bear to the school, but a number of points of detail require some consideration, however briefly and imperfectly I can deal with them. In the first place there is the important question of the limitations which should be fixed to the entrance into the university; what qualifications should be required of those who propose to take advantage of the higher training offered by the university. On the one hand, it is obviously desirable that the time and opportunities of the university should not be wasted in conferring such elementary instruction as can be obtained elsewhere; while, on the other hand, it is no less desirable that the higher instruction of the university should be made accessible to everyone who can take advantage of it, although he may not have been able to go through any very extended course of education. My own feeling is distinctly against any absolute and defined preliminary examination, the passing of which shall be an essential condition of admission to the university. I would admit any one to the university who could be reasonably expected to profit by the instruction offered to him, and I should be inclined, on the whole, to test the fitness of the student, not by examination before he enters the university, but at the end of his first term of study. If, on examination in the branches of knowledge to which he has devoted himself, he show himself deficient in industry or in capacity, it will be best for the university and best for himself, to prevent him from pursuing a vocation for which he is obviously not fit. And I hardly know of any other method than this by which his fitness or unfitness can be safely ascertained, though no doubt a good deal may be done, not by formal cut and dried examination, but by judicious questioning at the outset of his career.

Another very important and difficult practical question is whether a definite course of study shall be laid down for those who enter the university; whether a curriculum shall be prescribed; or whether the student shall be allowed to range at will among the subjects which are open to him. And this question is inseparably connected with another, namely, the conferring of degrees. It is obviously impossible that any student should pass through the whole of the series of courses of instruction offered by a university. If a degree is to be conferred as a mark of proficiency in knowledge, it must be given on the ground that the candidate is proficient in a certain fraction of those studies; and then will arise the necessity of insuring an equivalency of degrees, so that the course by which a degree is obtained shall mark approximately an equal amount of labour and of acquirements, in all cases. But this equivalency can hardly be secured in any other way than by prescribing a series of definite lines of study. This is a matter which will require grave consideration. The important points to bear in mind, I think, are that there should not be too many subjects in the curriculum, and that the aim should be the attainment of thorough and sound knowledge of each.

One half of the Johns Hopkins bequest is devoted to the establishment of a hospital, and it was the desire of the testator that the university and the hospital should co-operate in the promotion of medical education. The trustees will unquestionably take the best advice that is to be had as to the construction and administration of the hospital. In respect to the former point, they will doubtless remember that a hospital may be so arranged as to kill more than it cures; and, in regard to the latter, that a hospital may spread the spirit of pauperism among the well to do, as well as relieve the sufferings of the destitute. It is not for me to speak on these topics—rather let me confine myself to the one matter on which my experience as a student of medicine, and an examiner of long standing, who has taken a great interest in the subject of medical education, may entitle me to a hearing. I mean the nature of medical education itself, and the co-operation of the university in its promotion.

What is the object of medical education? It is to enable the practitioner, on the one hand, to prevent disease by his knowledge of hygiene; on the other hand, to divine its nature, and to alleviate or cure it, by his know-knowledge of pathology, therapeutics, and practical medicine. That is his business in life, and if he has not a thorough and practical knowledge of the conditions of health, of the causes which tend to the establishment of disease, of the meaning of symptoms, and of the uses of medicines and operative appliances, he is incompetent, even if he were the best anatomist, or physiologist, or chemist that ever took a gold medal or won a prize certificate. This is one great truth respecting medical education. Another is, that all practice in medicine is based upon theory of some sort or other; and therefore, that it is desirable to have such theory in the closest possible accordance with fact. The veriest empiric who gives a drug in one case because he has seen it do good in another of apparently the same sort, acts upon the theory that similarity of superficial symptoms means similarity of lesions; which, by the way, is perhaps as wild an hypothesis as could be invented. To understand the nature of disease we must understand health, and the understanding of the healthy body means the having a knowledge of its structure and of the way in which its manifold actions are performed, which is what is technically termed human anatomy and human physiology. The physiologist again must needs possess an acquaintance with physics and chemistry, inasmuch as physiology is, to a great extent, applied physics and chemistry. For ordinary purposes a limited amount of such knowledge is all that is needful; but for the pursuit of the higher branches of physiology no knowledge of these branches of science can be too extensive, or too profound. What we call therapeutics again, which has to do with the action of drugs and medicines on the living organism is, strictly speaking, a branch of experimental physiology, and is daily receiving a greater and greater experimental development.

The third great fact which is to be taken into consideration in dealing with medical education, is that the practical necessities of life do not, as a rule, allow aspirants to medical practice to give more than three, or it may be four years to their studies. Let us put it at four years, and then reflect that in the course of this time a young man fresh from school has to acquaint himself with medicine, surgery, obstetrics, therapeutics, pathology, hygiene, as well as with the anatomy and the physiology of the human body; and that his knowledge should be of such a character that it can be relied upon in any emergency, and always ready for practical application. Consider, in addition, that the medical practitioner may be called upon, at any moment, to give evidence in a court of

justice in a criminal case, and that it is therefore well that he should know something of the laws of evidence, and of what we call medical jurisprudence. On a medical certificate a man may be taken from his home and from his business and confined in a lunatic asylum; surely, therefore, it is desirable that the medical practitioner should have some rational and clear conceptions as to the nature and symptoms of mental disease. Bearing in mind all these requirements of medical education, you will admit that the burden on the young aspirant for the medical profession is somewhat of the heaviest, and that it needs some care to prevent his intellectual back from being broken.

Those who are acquainted with the existing systems of medical education will observe that, long as is the catalogue of studies which I have enumerated, I have omitted to mention several that enter into the usual medical curriculum of the present day. I have said not a word about zoology, comparative anatomy, botany, or materia medica. Assuredly this is from no light estimate of the value or importance of such studies in themselves. It may be taken for granted that I should be the last person in the world to object to the teaching of zoology or comparative anatomy in themselves; but I have the strongest feeling that, considering the number and the gravity of those studies through which a medical man must pass, if he is to be competent to discharge the serious duties which devolve upon him, subjects which lie so remote as these do from his practical pursuits should be rigorously excluded. The young man, who has enough to do in order to acquire such familiarity with the structure of the human body as to enable him to perform the operations of surgery, ought not, in my judgment, to be occupied with investigations into the anatomy of crabs and starfishes. Undoubtedly the doctor should know the common poisonous plants of his own country when he sees them, but that knowledge may be obtained by a few hours devoted to the examination of specimens of such plants, and the desirableness of such knowledge is no justification, to my mind, for spending three months over the study of systematic botany. Again, materia medica, so far as it is a knowledge of drugs, is the business of the druggist. In all other callings the necessity of the division of labour is fully recognised, and it is absurd to require of the medical man that he should not avail himself of the special knowledge of those whose business it is to deal in the drugs which he uses. It is all very well that the physician should know that castor oil comes from a plant, and castoreum from an animal, and how they are to be prepared, but for all practical purposes of his profession that knowledge is not of one whit more value, has no more relevancy, than the knowledge of how the steel of his scalpel is made.

All knowledge is good. It is impossible to say that any fragment of knowledge, however insignificant or remote from one's ordinary pursuits, may not some day be turned to account. But in medical education, above all things, it is to be recollected that in order to know a little well one must be content to be ignorant of a great deal.

Let it not be supposed that I am proposing to narrow medical education, or, as the cry is, to lower the standard of the profession. Depend upon it there is only one way of really ennobling any calling, and that is to make those who pursue it real masters of their craft, men who can truly do that which they profess to be able to do, and which they are credited with being able to do by the public; and there is no position so ignoble as that of the so-called "liberally-educated practitioner," who, as Talleyrand said of his physician, "Knows everything, even a little physic;" who may be able to read Galen in the original, who knows all the plants, from the cedar of Lebanon to the hyssop upon the wall, but who finds himself, with the issues of life and death in his hands, ignorant, blundering, and bewildered, because of his ignorance of the essential and fundamental truths upon which practice must be based. Moreover, I venture to say, that any man who has seriously studied all the essential branches of medical knowledge; who has the needful acquaintance with the elements of physical science, who has been brought by medical jurisprudence into contact with law; whose study of insanity has taken him into the fields of psychology; has *ipso facto* received a liberal education.

Having lightened the medical curriculum by culling out of it everything which is unessential, we may next consider whether something may not be done to aid the medical student toward the acquirement of real knowledge by modifying the system of examination. In England, within my recollection, it was the practice to require of the medical student attendance on lectures upon the most diverse topics during three years; so that it often happened that he would have to listen to four or five lectures in the day upon totally different subjects in addition to the hours given to dissection and to hospital practice: and he was required to keep all the knowledge he could pick up in this distracting fashion at examination point, until at the end of three years he was set down to a table and questioned pell-mell upon all the different matters with which he had been striving to make acquaintance. A worse system and one more calculated to obstruct the acquisition of sound knowledge and to give full play to the "crammer" and the "grinder" could hardly have been devised by human ingenuity. Of late years great reforms have taken place. Examinations have been divided so as to diminish the number of subjects among which the attention has to be divided. Practical examination has been largely introduced, but there still remains, even under the present system, too much of the old evil inseparable from the contemporaneous pursuit of a multiplicity of diverse studies.

Proposals have recently been made to get rid of general examinations altogether, to allow the student to be examined in each subject at the end of his attendance on the class; and then, in case of the result being satisfactory, to allow him to have done with it; and I may say that this method has been pursued for many years in the Royal School of Mines in London, and has been found to work very well. It allows the student to concentrate his mind upon what he is about for the time being, and then to dismiss it. Those who are occupied in intellectual work, will, I think, agree with me that it is important not so much to know a thing as to have known it, and known it thoroughly. If you have once known a thing in this way it is easy to renew your knowledge when you have forgotten it; and when you begin to take the subject up again, it slides back upon the familiar grooves with great facility.

Lastly comes the question as to how the university may co-operate in advancing medical education. A medical school is strictly a technical school—a school in which a practical profession is taught—while a university ought to be a place in which knowledge is obtained without direct reference to professional purposes. It is clear, therefore, that a university and its antecedent, the school, may best co-operate with the medical school by making due provision for the study of those branches of knowledge which lie at the foundation of medicine.

At present, young men come to the medical schools without a conception of even the elements of physical science; they learn, for the first time, that there are such sciences as physics, chemistry, and physiology, and are introduced to anatomy as a new thing. It may be safely said that with a large proportion of medical students much of the first session is wasted in learning how to learn—in familiarising themselves with utterly strange conceptions, and in awakening their dormant and wholly untrained powers of observation and of manipulation. It is difficult to over-estimate the magnitude of the obstacles

which are thrown in the way of scientific training by the existing system of school education. Not only are men trained in mere book-work, ignorant of what observation means, but the habit of learning from books alone begets a disgust of observation. The book-learned student will rather trust to what he sees in a book than to the witness of his own eyes.

There is not the slightest reason why this should be so, and, in fact, when elementary education becomes that which I have assumed it ought to be, this state of things will no longer exist. There is not the slightest difficulty in giving sound elementary instruction in physics, in chemistry, and in the elements of human physiology in ordinary schools. In other words, there is no reason why the student should not come to the medical school provided with as much knowledge of these several sciences as he ordinarily picks up in the course of his first year of attendance at the medical school.

I am not saying this without full practical justification for the statement. For the last eighteen years we have had in England a system of elementary science teaching carried out under the auspices of the Science and Art Department, by which elementary scientific instruction is made readily accessible to the scholars of all the elementary schools in the country. Commencing with small beginnings, carefully developed and improved, that system now brings up for examination as many as seven thousand scholars in the subject of human physiology alone; and I can say that out of that number a large proportion have acquired a fair amount of substantial knowledge, and that no inconsiderable percentage show as good an acquaintance with human physiology as used to be exhibited by the average candidates for medical degrees in the University of London when I was first an examiner there twenty years ago, and quite as much knowledge as is possessed by the ordinary student of medicine at the present day. I am justified, therefore, in looking forward to the time when the student who proposes to devote himself to medicine will come, not absolutely raw and inexperienced as he is at present, but in a certain state of preparation for further study; and I look to the university to help him still further forward in that stage of preparation, through the organisation of its biological department. Here the student will find means of acquainting himself with the phenomena of life in their broadest acceptation. He will study not botany and zoology, which, as I have said, would take him too far away from his ultimate goal; but, by duly arranged instruction, combined with work in the laboratory upon the leading types of animal and vegetable life, he will lay a broad and at the same time solid foundation of biological knowledge; he will come to his medical studies with a comprehension of the great truths of morphology and of physiology, with his hands trained to dissect and his eyes taught to see. I have no hesitation in saying that such preparation is worth a full year added on to the medical curriculum. In other words, it will set free that much time for attention to those studies which bear directly upon the student's most grave and serious duties as a medical practitioner.

Up to this point I have considered only the teaching aspect of your great foundation, that function of the university in virtue of which it plays the part of a reservoir of ascertained truth, so far as our symbols can ever interpret nature. All can learn; all can drink of this lake. It is given to few to add to the store of knowledge, to strike new springs of thought, or to shape new forms of beauty. But so sure as it is that men live not by bread, but by ideas, so sure is it that the future of the world lies in the hands of those who are able to carry the interpretation of nature a step further than their predecessors, so certain is it that the highest function of a university is to seek out those men, cherish them, and give their ability to serve their kind full play.

I rejoice to observe that the encouragement of research occupies so prominent a place in your official documents, and in the wise and liberal inaugural address of your president. This subject of the encouragement, or, as it is sometimes called, the endowment of research, has of late years greatly exercised the minds of men in England. It was one of the main topics of discussion by the members of the Royal Commission of whom I was one, and who not long since issued their report, after five years' labour. Many seem to think that this question is mainly one of money; that you can go into the market and buy research, and that supply will follow demand, as in the ordinary course of commerce. This view does not commend itself to my mind. I know of no more difficult practical problem than the discovery of a method of encouraging and supporting the original investigator without opening the door to nepotism and jobbery. My own conviction is admirably summed up in the passage of your president's address, "that the best investigators are usually those who have also the responsibilities of instruction, gaining thus the incitement of colleagues, the encouragement of pupils, and the observation of the public."

At the commencement of this address I ventured to assume that I might, if I thought fit, criticise the arrangements which have been made by the board of trustees, but I confess that I have little to do but to applaud them. Most wise and sagacious seems to me the determination not to build for the present. It has been my fate to see great educational funds fossilise into mere bricks and mortar, in the petrifying springs of architecture, with nothing left to work the institution they were intended to support. A great warrior is said to have made a desert and called it peace. Administrators of educational funds have sometimes made a palace and called it a university. If I may venture to give advice in a matter which lies out of my proper competency, I would say that whenever you do build, get an honest bricklayer, and make him build you just such rooms as you really want, leaving ample space for expansion. And a century hence, when the Baltimore and Ohio shares are at one thousand premium, and you have endowed all the professors you need, and built all the laboratories that are wanted, and have the best museum and the finest library that can be imagined; then if you have a few hundred thousand dollars you don't know what to do with, send for an architect and tell him to put up a façade. If American is similar to English experience, any other course will probably lead you into having some stately structure, good for your architect's fame, but not in the least what you want.

It appears to me that what I have ventured to lay down as the principles which should govern the relations of a university to education in general, is entirely in accordance with the measures you have adopted. You have set no restrictions upon access to the instruction you propose to give; you have provided that such instruction, either as given by the university or by associated institutions, should cover the field of human intellectual activity. You have recognised the importance of encouraging research. You propose to provide means by which young men, who may be full of zeal for a literary or for a scientific career, but who also may have mistaken aspiration for inspiration, may bring their capacities to a test and give their powers a fair trial. If such an one fail, his endowment terminates and there is no harm done. If he succeed, you may give power of flight to the genius of a Davy or a Faraday, a Carlyle or a Locke, whose influence on the future of his fellow men shall be absolutely incalculable.

You have enunciated the principle that the "Glory of the university should rest upon the character of the teachers and scholars, and not upon their numbers or buildings constructed for their use." And I look upon it as an essential and most important feature of your plan

that the income of the professors and teachers shall be independent of the number of students whom they can attract. In this way you provide against the danger, patent elsewhere, of finding attempts at improvement obstructed by vested interests; and in the department of medical education especially, you are free of the temptation to set loose upon the world men utterly incompetent to perform the serious and responsible duties of their profession.

It is a delicate matter for a stranger to the practical working of your institutions, like myself, to pretend to give an opinion as to the organisation of your governing power. I can conceive nothing better than that it should remain as it is, if you can secure a succession of wise, liberal, honest, and conscientious men to fill the vacancies that occur among you. I do not greatly believe in the efficacy of any kind of machinery for securing such a result, but I would venture to suggest that the exclusive adoption of the method of co-optation for filling the vacancies which must occur in your body appears to me to be somewhat like a tempting of Providence. Doubtless there are grave practical objections to the appointment of persons outside of your body and not directly interested in the welfare of the university; but might it not be well if there were an understanding that your academic staff should be officially represented on the board, perhaps even the heads of one or two independent learned bodies, so that academic opinion and the views of the outside world might have a certain influence in that most important matter, the appointment of your professors? I throw out these suggestions, as I have said, in ignorance of the practical difficulties that may be in the way of carrying them into effect, on the general ground that personal and local influences are very subtle, and often unconscious, while the future greatness and efficiency of the noble institution which now commences its work must largely depend upon its freedom from them.

I constantly hear Americans speak of the charm which our old mother country has for them, of the delight with which they wander through the streets of ancient towns, or climb the battlements of mediæval strongholds, the names of which are indissolubly associated with the great epochs of that noble literature which is our common inheritance; or with the blood-stained steps of that secular progress, by which the descendants of the savage Britons and of the wild pirates of the North Sea have become converted into warriors of order and champions of peaceful freedom, exhausting what still remains of the old Berserk spirit in subduing nature, and turning the wilderness into a garden. But anticipation has no less charm than retrospect, and to an Englishmen landing upon your shores for the first time, travelling for hundreds of miles through strings of great and well-ordered cities, seeing your enormous actual, and almost infinite potential, wealth in all commodities, and in the energy and ability which turn wealth to account, there is something sublime in the vista of the future. Do not suppose that I am pandering to what is commonly understood by national pride. I cannot say that I am in the slightest degree impressed by your bigness, or your material resources, as such. Size is not grandeur, and territory does not make a nation. The great issue, about which hangs a true sublimity, and the terror of overhanging fate, is what are you going to do with all these things? What is to be the end to which these are to be the means? You are making a novel experiment in politics on the greatest scale which the world has yet seen. Forty millions at your first centenary, it is reasonably to be expected that, at the second, these states will be occupied by two hundred millions of English-speaking people, spread over an area as large as that of Europe, and with climates and interests as diverse as those of Spain and Scandinavia, England and Russia. You and your descendants have to ascertain whether this great mass will hold together under the forms of a republic, and the despotic reality of universal suffrage; whether state rights will hold out against centralisation without separation; whether centralisation will get the better without actual or disguised monarchy; whether shifting corruption is better than a permanent bureaucracy; and as population thickens in your great cities, and the pressure of want is felt, the gaunt spectre of pauperism will stalk among you, and communism and socialism will claim to be heard. Truly America has a great future before her; great in toil, in care, and in responsibility; great in true glory if she be guided in wisdom and righteousness; great in shame if she fail. I cannot understand why other nations should envy you, or be blind to the fact that it is for the highest interest of mankind that you should succeed; but the one condition of success, your sole safeguard, is the moral worth and intellectual clearness of the individual citizen. Education cannot give these, but it can cherish them and bring them to the front in whatever station of society they are to be found; and the universities ought to be and may be the fortresses of the higher life of the nation.

May the university which commences its practical activity to-morrow abundantly fulfil its high purpose; may its renown as a seat of true learning, a centre of free inquiry, a focus of intellectual light, increase year by year, until men wander hither from all parts of the earth, as of old they sought Bologna, or Paris, or Oxford.

And it is pleasant to me to fancy that among the English students who are drawn to you at that time there may linger a dim tradition that a countryman of theirs was permitted to address you as he has done to-day, and to feel as if your hopes were his hopes and your success his joy.

REV. MARK PATTISON ON UNIVERSITY REFORM

ONE of the most valuable addresses at the Social Science Congress at Liverpool was that by the Rev. Mark Pattison, last Friday, on the subject of Education. He confined his remarks mainly to Lord Sandon's Bill and the Oxford and Cambridge Bills. In passing, however, he spoke in the strongest terms of the miserable state of the middle-class schools, "the wretched destitution of all intellectual nourishment in which the middle classes of England grow up." With regard to the Education Bill, Mr. Pattison showed that elementary education was in anything but a satisfactory condition, that as yet we have only the beginning of a school system. He then spoke at considerable length on the Oxford and Cambridge Bills, which our readers will remember were withdrawn last session on the distinct understanding that they should be introduced next session. Mr. Pattison referred to the scheme for endowing the University at the expense of the Colleges, and to Lord Salisbury's declaration that one purpose of the measure was "to promote science and learning." Mr. Pattison went on to say:—"When the Oxford Bill got down into the Commons the member of the Cabinet who had the charge of it there hastened to disavow any such intentions on the part of his Government. Lord Salisbury's declaration had been made in the House of Lords, and in the Upper House it did not seem altogether absurd to speak of science and learning in connection with a University. But such flimsy and unpractical notions are not for the atmosphere of the Lower House. Members of the Government in the Lower House vied with each other in eagerly repudiating any intention of making the University a seat of learning and science. This had been an unauthorised escapade of their impulsive colleague in the Lords. This disavowal was well received in the House. Antagonism was half disarmed. The member of the learned University of Oxford received the congratulations of the member of the learned University of Lon-

don in having done with all that nonsense. The Bill that has been dropped was a Bill empowering certain commissioners to take funds now devoted to College purposes and devote them to university purposes. What these university purposes are is not stated—is not known—not known even to the promoters of the Bill. All that is known is that among those purposes is not the promotion of science and learning. This purpose, which was announced by Lord Salisbury, has been anxiously disavowed by Lord Salisbury's colleagues. In these circumstances it cannot be any great matter for regret that the Universities Bill should have been laid aside."

Mr. Pattison then spoke of the University itself. He briefly showed how our two great universities, from being national, became State Church institutions, and that notwithstanding the abolition of the Test Act, the ecclesiastical spirit is still practically supreme.

Something might be done to counteract this sinister influence by opening the headships of colleges to laymen, and by attaching to the University a number of eminent men of science. The universities, moreover, he went on to show, are anything but popular; with a population of twenty-one millions, and realised property of 6,000 millions, the total number of university students does not exceed 6,000 out of 114,000 males between eighteen and twenty-one that ought to be receiving a high-class education. This state of things, Mr. Pattison justly says, can be described as nothing less than a state of national destitution—an intellectual blight. It is not the mere cost, though this is large enough as contrasted with the cost of university education in Scotland and Germany, that deters the middle classes from sending their sons to a university, it is the prevalent belief that, unless to a professional man, a university education is worse than useless. Mr. Pattison then went on to show what he thinks a university ought to be.

"Universities are not to fit men for some special mode of gaining a livelihood; their object is not to teach law or divinity, banking, or engineering, but to cultivate the mind and form the intelligence. A university should be in possession of all science and all knowledge, but it is as science and knowledge, not as a money-bringing pursuit, that it possesses it. There is an old saying—so old that it is quite forgotten even in the universities—'A university is founded on arts'—founded, that is, its fabric of the special sciences is raised upon the liberal studies. Men are men, whether they are lawyers or physicians, merchants or manufacturers— they possess an intellect and a conscience; and it is with these as men, and not as lawyers or physicians, merchants or manufacturers, that liberal education has to do. What professional men should carry away with them from the university is not professional knowledge, but that which directs the use of their professional knowledge, and brings the light of general culture to illuminate the technicalities of a special pursuit. To go to Cambridge, like the youth in the old Latin grammar, "*ad capiendum ingenii cultum*," seems to the practical Englishman like telling him to feed on moonshine. The idea of education is a lost idea among the middle classes. When his school-time is over—and a very unprofitable time it has mostly been to him—he can't conceive that there is anything beyond, except qualifying for a bread-winning profession. The reason why the son of a wealthy middle-class family is not at the university is exactly the same as the reason why the son of a day-labourer is not at the village school. He does not see the good of it."

Mr. Pattison then referred to a statement made by Mr. Smith, of Halifax, at the Brighton meeting, that if parents saw their way to getting 5 per cent. on the sum laid out on a girl's education, then they would be as ready to spend 2,000*l*. on that as they are on a boy's.

"Mr. Smith, of Halifax, was very likely worth thousands; but his view is precisely the view of John Nokes, the day-labourer in our village, who doesn't want his boy 'to have no school-larning; he never saw no good come of it; the boy don't get more wages by it.' John Nokes earns twenty shillings a week; Mr. Smith, of Halifax, has 5 per cent. upon many thousands of pounds; but their ideas of education are the same—no sense of the value of life, of the intrinsic worth of the human soul, and of its capacities for being trained. Man or woman is a machine for earning an income. The charm and beauty of life, as it can be lived and adorned, is wholly unknown. The work of the British workman, we say, is deteriorated because he cares nothing for the work itself, but only for the wages it is to bring him in. At this we are all indignant. We have little right to be so, when we ourselves care as little for life for life's sake as he does for art for art's sake. It may be confidently asserted, then, that the universities in any country cannot rise above public instruction generally. They may fall below it."

Mr. Pattison then showed that the great reforms in the Oxford University curriculum during the last sixty or seventy years have been forced upon her from without.

"It is no longer now a question of breaking up the old monopoly of Latin and Greek, and of the introduction of a few popular branches of instruction by the side of the old. A far wider conception of a university has now been opened up, and of the function it is expected to fulfil for the nation at large. This conception is a consequence of the position which science has come to occupy in the world in the last quarter of a century. When scientific men had to speak to the wider public fifty years ago they used to dwell on the various applications of science to the arts of life. The industrial value of scientific knowledge had then to be inculcated. It was from this point of view that science first got recognition. This has been successfully done. Facts stronger than arguments have sufficiently proved the utility of scientific knowledge. On this point no more needs to be said. The public are alive to the truth. But a new consideration now emerges out of this proved utility. Science has been incessantly growing since the close of the great European war of 1815. It has been extending its boundaries, enlarging its mass, increasing its complexity, disclosing inner harmonies, and bringing the world of thought, of work, of life within its grasp. All this growth and movement has taken place outside the universities. Our most considerable names in science have often not been university men; when they have been so their scientific activity has been quite apart from their university employment. This scientific atmosphere, this consciousness of a common aim and a common inspiration among a multitude of labourers—this active pursuit of truth, which forms a bond as strong as the bond of charity—this is not the atmosphere of our universities. There exists, then, in the world outside a vast body of knowledge, of the importance of which intelligent people are well aware. And there exist inside the universities, colleges with considerable endowments. What is more natural than the wish to bring these two separate existences together? How are we to provide for the maintenance and transmission of all this rich treasure of knowledge which has been painfully accumulating in the past? Can a more proper place for the purpose be found than in our universities? A university, says Prof. Huxley, is a corporation which has charge of the interests of knowledge as such, the business of which is to represent knowledge by the acquirements of its members and to increase it by their studies. The change demanded consists in a change of the atmosphere of the university, in the diffusion of a disinterested love of knowledge. It may be that legislation can do little to promote it. But there is one change which legislation only can make, and which is a necessary condition of the establishment of a system of scientific study and instruction. This is the removal of the fellowship system. The history of this peculiar institution has been often given of late, and the

time does not now allow of my repeating it. Suffice it to say that the present operation of these valuable prizes is directly antagonistic to their supposed objects. Instead of promoting science and learning they serve only to make the university an arena in which young men contend for money prizes, and those who should be teachers are engrossed in training, handicapping, and settling the conditions of the race. The operation of emulation, honours, and prizes as a stimulus in school education is somewhat doubtful. But in the highest stage of liberal education it is necessary, if science and letters are to work with their cultivating effect on the mind, that they should be disengaged from all mercenary attractions. But when prizes of such magnitude as Fellowships are employed to attract students they become themselves the all-engrossing objects of pursuit. In Oxford and Cambridge, taken together, an amount of not less than 150,000*l.* a-year is spent on prizes. The sum is in itself an insignificant fraction of the national income, but it far exceeds the whole outlay which the country makes on science and learning. The bestowal of these lavish prizes corrupts instruction at its sources. No reform, having for its object to make the universities the home of science and learning, can be effectual which does not begin by suppressing this wholesale pensioning of youthful sinecurists. I have reminded you of one old academical saying; there is another which recurs now to my recollection, 'A Fellowship is the grave of learning.' I have spoken only of our old Universities, or rather of Oxford, because I know it best. But I must not forget that there are younger institutions which are struggling upwards towards the ideal of a university, as I have described it in Prof. Huxley's words, 'a corporation which has charge of the interests of knowledge as such.' At the head of these I must place Owens College, not only because it is in Lancashire, but because in its staff of Professors it possesses a body of men who are truly representative of knowledge in a variety of its most important departments. In a single generation we have seen this College rise from humble beginnings to a position in which it can put forward a claim to be incorporated as a university, with the privilege of giving degrees. Its capitalised sources are, indeed, small. In addition to the original 100,000*l.* of Owens' bequest, about 220,000*l.* has been contributed by voluntary subscribers, an insignificant sum when compared with the wealth of the great manufacturing metropolis. These funds, too, have been raised almost exclusively in a very small circle and by a very few public-spirited individuals; they have not been drawn from the general mass of manufacturing wealth in Manchester or the neighbouring district. With material means so inadequate, the scientific eminence attained by this young institution is a remarkable example of intellectual vigour, which must dispose us to regard favourably its claims to incorporation. But there is, besides, an immediate practical requirement which compels Owens College to seek without delay the right of conferring degrees. It is this: that as long as its students are under the necessity of graduating through the University of London, they must pass through the examinations required for the London degree. Consequently the professors of Owens College can never take the free and independent position of teachers of science. It is inevitable that they must prepare their pupils for examination, and every true teacher knows too well that this process is incompatible with genuine instruction in letters and science. The efficiency of a local university is not to be measured by the amount of its annual income, nor its success by the number of its pupils. Does it profess to teach and represent human knowledge in all its main branches and in its most complete forms? Is each great department occupied by men who are in possession of the long tradition of the past and zealous in searching out what still remains unexplored? Is liberal culture recognised as its basis, and progressive science as its aim? Where these conditions are fulfilled it would be hard to say why such an institution should not be entrusted by the State with the privilege of marking its students with the public stamp of certified acquirement. If it were merely a question of comparative qualification it would be difficult to maintain that Durham possesses, and that Owens College does not possess, the capacities, extensive and intensive, which I have supposed to be required. But if in the next twenty years the growth of Owens College is in proportion to its advance in the last twenty, the question will by that time have settled itself"

No words of ours could add to the force of this address, coming as it does from one in the position of its author. When we contrast the actual state of things in our English Universities with the ideal which appears in the above address and in that of Prof. Huxley at Baltimore—an ideal which has almost become a reality in America—any well-wisher of his country and of learning cannot but feel regret at the opportunities that have been lost, and the almost hopelessness of any rapid improvement.

THE FIFTH MEETING OF RUSSIAN NATURALISTS

THE fifth meeting of Russian Naturalists was opened September 12 at Warsaw. The Russian Naturalists are not yet organised into a permanent association, although it is their wish, repeatedly expressed, to found an association on the same principles as the British. A special imperial permission must still be obtained before each meeting, the rules of the meeting being settled by imperial decree, and a sum of money allowed for expenses and publications. The sittings of the sections are open only to members and persons introduced by them, membership being allowed only to those who have made direct contributions to science, as ordained by the rules. The meetings of the united sections for the transaction of general business and for lectures of general interest, are held in public, usually in presence of a numerous audience. The meeting (for it can hardly be called an association) publishes a daily bulletin of transactions, and issues, in the course of the year, one or two large volumes of memoirs (*Troody*) containing lectures, and longer papers *in extenso*, together with such contributions as separate societies of naturalists have found too expensive to publish in their journals.

The Warsaw meeting was largely attended by naturalists from all parts of Russia, but especially from St. Petersburg, Moscow having but few representatives. The number of members was about three hundred, the sections of Scientific Medicine and Chemistry being especially full. There were very few foreign naturalists, the organising committee not being allowed by the rules to send invitations abroad. Prof. Brodofsky, president of the Committee, was elected president of the meeting, and the St. Petersburg professors, Mendeléeff and Butleroff, vice-presidents. The ten sections of the meeting transacted a great deal of business during the nine days the Naturalists were assembled, and we may give afterwards some account of the papers read, referring now only to lectures delivered at public meetings.

At the first meeting Prof. Dobrzycki read an interesting medical paper, "On the Principles of Research into the Causes of Diseases." Several propositions as to the permanent organisation of future meetings, the opening of a Society of Naturalists at the Warsaw University on the principles adopted for the societies already existing in connection with all universities in Russia, the holding of an international meeting of naturalists, and the publication of an international daily scientific paper, were read and referred for discussion to the sections.

The second public meeting was especially crowded with the public. Two papers were read by Prof. Goyer

and Prof. Halubinsky. The former, "On the Importance of Practical Scientific Institutions" (laboratories, physical cabinets, zoological stations, &c.), insisted on the necessity of such institutions for the successful teaching of natural science, and pointed out how little time is generally allowed in universities for the practical study of science, the greater part of the students' time being occupied by the lectures of the professors. M. Goyer forcibly illustrated the influence exercised by practical studies on the student, not only by affording him the only possible means of acquiring a profound knowledge of science, but especially by developing the independence of his judgment, the critical powers of his mind, and his inventive faculties.

The lecture of Prof. Halubinsky, "On the Genetic Method in the Teaching of Natural Science," treated a closely allied subject. The professor pointed out the deplorable state to which the teaching of natural science was lately reduced in Russian colleges, and insisted that only a thorough study of the natural sciences can adequately develop the analytical faculties of the mind, and that such development cannot be sufficiently attained by the study of languages and mathematics. He insisted further on the urgent necessity of fundamental changes in the arrangement of most of our handbooks of natural sciences, these handbooks beginning mostly with generalisations, instead of simply helping the scholar to arrive at them himself by means of comparison and of the analysis of the properties of objects and phenomena. The lecture provoked a lively discussion, some opposition being manifested by college teachers.

Prof. Famintzin presented Collections (*Sborniki*) made from separate copies of all papers published since the last meeting in the *Memoirs* of the six Societies of Naturalists annexed of the universities. The societies having agreed to print their journals in one uniform size, 100 separate copies of each paper published are sent to the St. Petersburg Society which makes up from them *Recueils* arranged under the heads of Geology, Botany, and Zoology. Thus those who are interested in only one of these branches can dis ense with purchasing whole periodicals, the *Recueils* being sold at the St. Petersburg Society at a very low price. Here is a fine example for imitation by our various English provincial societies.

The proposal to request from the Minister of Public Instruction permission to found a Society of Naturalists at Warsaw, was met most favourably, as well as the proposal of Prof. Wagner to establish on the Solovetzky Islands a Zoological Station on the same principles as that at Sebastopol; as also was the proposal of M. Grimm to request the help of the Naval Department for dredgings in the Black Sea. MM. Grimm and Bogdanoff informed the meeting that they had undertaken two publications, a popular periodical, "Herald of Natural Science," for which they begged the co-operation of the naturalists, and a periodical in French or German, which would give to foreign readers brief notices of scientific work in Russia. This last idea was warmly supported by Prof. Mendeléeff, who proposed to request the government for pecuniary help for the publication; but this proposal having met with some opposition, it was returned for discussion in the sections.

A few excursions were made by the members, and a visit was paid, among others, to the Warsaw Institute for Deaf-Mutes and the Blind. The director of the Institute, Prof. Poplavsky, delivered on this occasion an interesting lecture on the causes of deaf-muteness, tracing them not only to the bad constitution of parents, but also to marriages between near relations. He energetically combated the opinion of Mr. George Darwin, who has endeavoured to prove by statistical evidence the fallacy of the generally accepted opinion as to the importance of the latter cause, and said that Mr. Darwin would probably change his opinions, had he the opportunity of examining the registers kept at the Warsaw Institute and elsewhere, as to the parentage of the deaf-and-dumb. The visitors had also an opportunity of witnessing the remarkable educational results arrived at by the Warsaw School. Mimic language being almost totally prohibited, the pupils are taught to understand the motion of the lips and to speak more or less distinctly; and after a four years' residence in the Institute they generally attain in both a high degree of perfection. The best result of the school is, that pupils who finish their education (technical) in the Institute immediately find employment in trades, the situations offered to them generally exceeding the number of candidates.

The usual dinner of naturalists was most animated, a very rare occasion now-a-days, as the correspondent of the *Golos* says, when Poles and Russians meet together in Warsaw. The want of friendship which was observable during the first days of the meeting, gradually disappeared, and all united most heartily in support of the toasts for the international influence of science, for the prosperity of natural science in schools, &c. Of course, a public meeting being now impossible in Russia without manifestations in favour of the struggle for independence of the southern Slaves, the usual collections were made, and a telegram was sent to General Tchernaieff with wishes for victory.

At the closing public meeting Dr. Rothe read a paper "On the Insane, and on Asylums for them." Treating the subject at great length, he concluded by animadverting on the insufficient number of asylums existing now in Russia, and proved by figures that the insane, when submitted to early medical treatment, recover in far larger numbers than is generally supposed; 70 per cent. if the treatment begins during the first months after the appearance of the disease, while those who enter the asylums with the disease about two years old, have hardly any chance of recovery. After the delivery of the lecture, various conclusions and propositions of the sections were discussed. St. Petersburg and Odessa being recommended as the place for the next meeting, a ballot decided in favour of the capital, the time of meeting to be announced during the coming winter. Resolutions were carried to request the Societies of Naturalists annexed to universities (which were organised by the initiative of the first meeting), to present in 1877 reports of their ten years activity; to change the name of the gathering into "Meeting of Naturalists and Physicians;" to raise a fund for a permanent student's scholarship in honour of Prof. Kessler, to whose initiative and many years' labours the first meeting was due. The proposal of Prof. Dobrzycki as to an inquiry into the causes of diseases, was negatived as involving too many practical difficulties, as were also the proposals of M. Vakoolofsky in reference to an international congress, daily scientific paper, &c. A committee, consisting of representatives of all sections, appointed to discuss the subject of a French-German periodical, warmly advocated the proposal, and the meeting coming finally to the conclusion that pecuniary help from the Government would be desirable, intrusted the societies of the St. Petersburg's University (Naturalist, Physical, and Chemical), to draw out rules for the conduct of the periodical. Discussions on subjects relative to the teaching of natural sciences in Governmental schools being totally prohibited in the meetings (in order to avoid opposition to the anti-Natural Science tendencies of the ministry), a pedagogical committee, appointed to discuss the proposals of Prof. Halubinsky, decided that permission should be requested from the ministry to allow the meetings a pedagogical section to discuss at least some of the more special questions relative to the subject. The conclusions of the committee were accepted, as well as those of the Zoological Section, to request from the Naval Department the use of ships for scientific explorations in Russian seas. Finally, the small sum produced by the members'

fees at the meeting (993 roubles from 331 members) was allowed for the publication of memoirs. The discussion of these various subjects having taken up much time, the members dispersed, and very few attended the lecture of M. Kostareff "On the Inductive and Deductive Methods of Reasoning and of Inquiry." The meeting was closed by a short address by the president, Prof. Brodofsky.

A. L.

PRINCIPLES OF TIME-MEASURING APPARATUS[1]

II.

The Pendulum.

IN that early apparatus I recently described, you will remember that the balance, after being set swinging in one direction, had its motion completely destroyed, and was then set swinging in the other, all by the direct agency of the clock-train. If it had possessed no other property than that merely of vibrating against the earth's attraction, the pendulum would have been an immense improvement upon this state of things, because every impulse delivered to it is, so to speak, stored up there, and is gradually expended therefrom as occasion requires in overcoming the friction due to its connections and the resistance of the atmosphere.

The discovery of the pendulum is generally attributed to Galileo, whose attention was attracted to the subject by watching the oscillations of a chandelier suspended

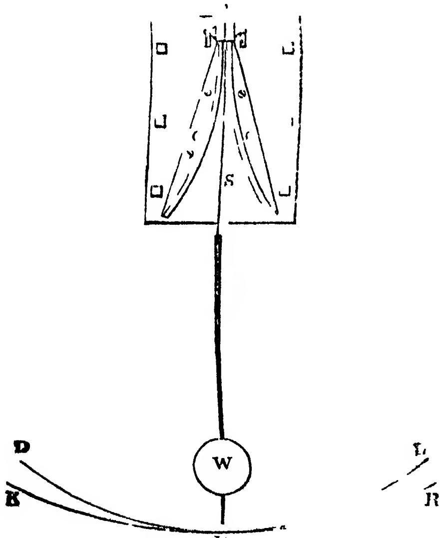


FIG. 9.

by a very long line at a church in Pisa. The story is very likely to be a true one; anybody observing the shorter oscillations of a very long pendulum (fifty or sixty feet in length say) could scarcely fail to be impressed by them.

The celebrated Dutch philosopher, Huygens, first worked out its theory. He discovered that if a pendulum, instead of swinging in a circular arc (which it obviously does) could be made to move in a cycloidal, it would perform all its oscillations, whether large or small, in precisely equal times.

He succeeded in obtaining this motion for his pendulums by the following contrivance (see Fig. 9):—Two curves or cheeks, C C, starting from the axis of motion are placed one upon each side of the pendulum, which is suspended by a flexible line or spring S. As the pendulum swings, this line wraps around either curve and deflects the pendulum from its circular path, K U R, into the cycloidal, D U L. As you could almost infer from inspection the time of a pendulum swinging a cycloidal, is rather faster than when it swings a circular arc, the cycloidal being the more rapid curve. Also the time of the swing of a pendulum in a circular arc gets longer as the swing increases, that is to say, as it travels further up the curve; for instance, if the arc of a pendulum which was swinging 2° was increased to 2½°, the loss of time due to the increased length of its swing would be four seconds a day.

The invention of these cycloidal cheeks or curves must have been looked upon as the *ne plus ultra* of perfection

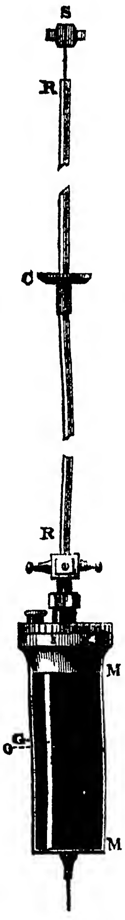


FIG 10

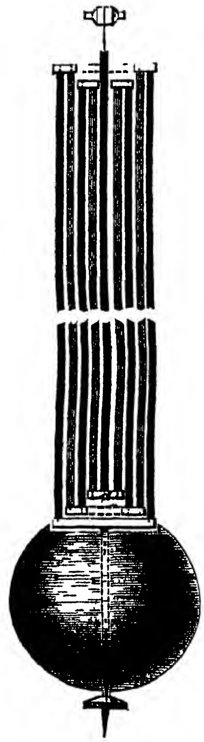


FIG 11

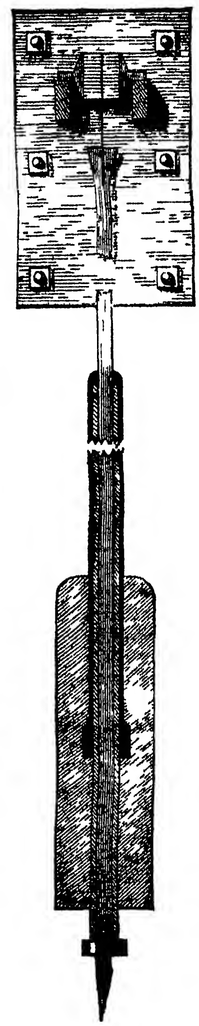


FIG. 12.

at the time; but in the first place they did not deflect the pendulum without a good deal of friction; and in the second it is rather advantageous than otherwise that a pendulum should gain in its shorter vibrations, because it never gets into them without retardation (which implies loss of time), and one error tends to correct the other.

Huygens also discovered that the time of one swing of a pendulum varies as the square root of its length. The length of a pendulum swinging in one second is nearly 39·2 inches, and if you wish to find the time in which a pendulum of any other length will perform one swing, you divide the square root of that length by the

[1] Lectures by Mr. H Dent Gardner, at the Loan Collection, South Kensington. Continued from p. 531.

square root of 39·2 inches; thus the time of the swing of a pendulum 61 inches long

$$= \frac{\sqrt{61}}{\sqrt{39\cdot2}} = \sqrt{\frac{61}{39\cdot2}} = 1\cdot25 = 1\tfrac{1}{4} \text{ seconds.}$$

On the other hand, if you wish to find the length of a pendulum to swing in a given time, all you need do is to multiply 39·2 by the square of the time; thus the length of a pendulum to swing in $\frac{1}{2}$ second $= 39\cdot2 \times (\frac{1}{2})^2 = 9\cdot8 = 9\frac{4}{5}$ inches.

But with reference to an ordinary clock pendulum, such as is shown in Fig. 10, you may ask me what is its length? do we measure its length from the point of suspension to the end or centre of the bob, or to the point at its extremity? We measure it to none of these places. Its true length is determined by multiplying every particle into the square of its distance from the point of suspension, adding all these together and dividing by the sum of every particle multiplied into its distance from the point of suspension simply. Of course an operation of

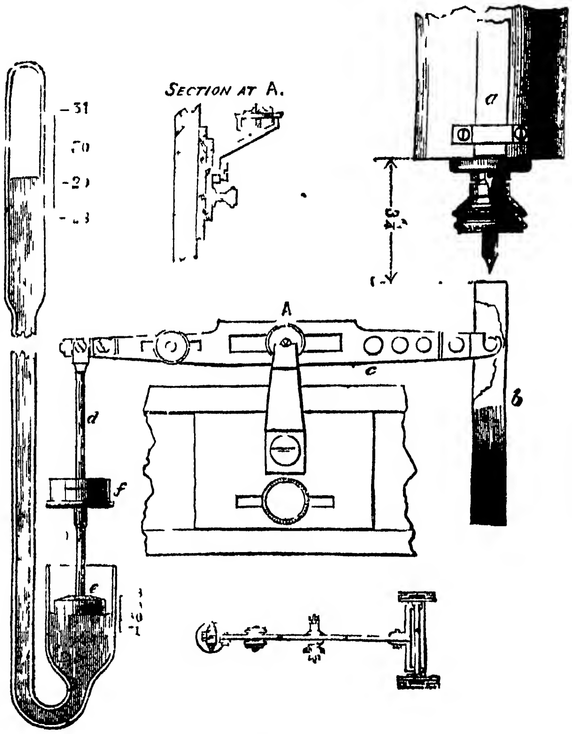


FIG 13

this kind is not very easily performed, but the upshot of the calculation is, in general, to give a distance to a certain point, O, called the centre of oscillation, just below the centre of gravity, G, of the pendulum. This is the true length of our pendulum so far as its time of vibration is concerned, and if we could take a perfectly simple pendulum (that is one with a rod without weight, and all the matter of its bob accumulated in one point at its extremity) of the same length, we should find that the times of their swings would exactly correspond.

What will happen if at any point above the centre of oscillation we add a little weight to our pendulum, say at point C? Evidently the effect is just the same as if we tied another short pendulum of length S C to our main one—it will urge it on and make it swing faster. At a point just half-way up the pendulum, the effect of any given weight will be greatest. From which follows the curious fact that a weight moved upwards or downwards away from this point will, in *either* case, increase the time of the swing of the pendulum, that is to say, make the clock lose.

The finer regulation of pendulums is performed upon the principle of adding or withdrawing weight at a point above the centre of oscillation. The collar C upon the pendulum, is placed there to carry subsidiary weights for the purpose.

The Pendulum Compensation.

Pendulums, like other things, lengthen as they get warmer, and shorten as they get colder, and the time of their swing is varied in consequence. For instance, a plain iron rod pendulum for every 10 degrees rise in the thermometer, will expand sufficiently to make the clock controlled by it lose nearly 3 seconds a day.

The earliest and one of the best methods of correcting or compensating this error is the mercurial pendulum designed by Graham (see Fig. 10). The bob of the pendulum is formed of a glass or iron vessel containing mercury, M M. When there is any increase of temperature, the rod R R expands and lets down the bob, but the mercury in the bob also expands, and from the manner it is confined expands upwards. The expansion of the mercury therefore tends to raise the centre of oscillation, and its amount is so calculated as exactly to neutralise and destroy whatever error would otherwise result from the lengthening of the rod. The action of this compensation may very readily be increased by adding or withdrawing a little of the mercury. Of course after each addition or withdrawal of mercury the clock will have to be regulated to time again by altering the nut upon its pendulum for the purpose.

A slight tendency to vary its rate after first being put up may sometimes be noticed in a clock fitted with one of these pendulums. This arises from air bubbles in the mercury, which gradually approach the surface; as they do so the mercury upon the other hand of course falls.

Another method of compensation is the gridiron pendulum of Harrison. Different metals expand at different rates, for instance

Steel expands	·000064	of its length.
Brass	,,	·0001	,,
Zinc	,,	·00017	,,

for every 10 degrees rise in temperature.

Suppose we take a central steel rod (see Fig. 11) about 3 feet long, and fasten to its extremity a cross piece *a*, upon which we erect two (for the sake of symmetry) brass rods, one upon each side of it; and to the summit of these we attach two other rods of steel, and at the extremity of these again two other rods of brass, and then let fall two more rods of steel, joined at their extremities by a cross piece, and to the cross piece attach the pendulum bob by another short length of steel so as to make up 39·2 inches of length between the centre of oscillation and the point of suspension. Supposing that the four supplementary lengths of brass and steel upon each side of the original steel rod average 2 feet 11 inches long, we have, in between the point of suspension and the centre of oscillation 109·2 inches of steel and 70 inches of brass, and further, that the expansion of this amount of brass is exactly equivalent to the expansion of the steel. But we have so arranged that all the brass expands *upwards* and all the steel *downwards*; therefore one destroys the other, and the position of the centre of oscillation does not change, whatever be the alteration of temperature. The worst of this method of compensation is, owing to the great weight of the rods, the centre of oscillation generally ceases approximately to correspond with the centre of gravity of the bob, and the true amount of compensation has to be determined by experiment, which is seldom done.

In the construction of compensation pendulums care must be taken that they are formed so that each part shall simultaneously take up any change of temperature. This

was brought prominently to light during the time that the normal sidereal clock for Greenwich was under trial. That clock had been fitted with a heavy mercurial pendulum, and it was found that the rod got warmer or colder some time in advance of the mercury; of course the compensation *failed* for such interval of time.

The following form of pendulum was afterwards substituted. The expansion of zinc is, as you see, nearly double that of brass, and consequently a good deal less of it is required to compensate a pendulum. To the extremity of an internal steel rod (see Fig. 12) a collar is fastened, and a zinc tube inclosing the steel rod rests upon it. To the summit of the zinc tube is attached a steel tube, which in turn incloses both it and the rod, and the pendulum bob is fastened midway of its length to the extremity of this tube. The outer steel tube is cut away at its sides, and holes bored in the zinc in order to let in changes of temperature rapidly.

The action of the combination is similar to that of the gridiron pendulum, the expansion of the zinc upwards exactly neutralising and destroying the expansion of the steel downwards. It is important (as suggested by Mr. Buckney) that the bob should be suspended at its centre, because otherwise it would also operate as an expansion length, and although its effect could be counterbalanced by shortening the zinc tube, yet owing to its bulk it would be sure to lag behind the rest of the compensation, and cause such an error as I have referred to.

Barometric Compensation.

When you aim at the very highest time-keeping, barometric compensation becomes necessary; that is to say, compensation against the disturbance to the pendulum due to changes of atmospheric pressure. For instance, when there is any rise in pressure, when the atmosphere becomes denser, our clock will lose, and will gain when the atmosphere becomes more attenuated, the variation in the Greenwich clock having been at about the rate of ·3 of a second a-day for a difference of one inch in the barometer.

The following compensation (see Fig. 13) is one designed by Sir George Airy :—

C is a lever moving around an axis at A. One arm of the lever carries a horse-shoe magnet, *b*, and the other a float, *e*, supported upon the mercury in a barometer cistern. Two bar magnets (the front one, *a*, only is shown, the other being behind the bob) are fastened upon the pendulum bob, the north pole of one pointing upwards, and of the other downwards (in order to render the combination astatic).

The poles of the horse-shoe magnet face the opposite poles of the two bar magnets, and attraction goes on between them. When the barometer rises the mercury in the cistern falls, and with it the float. The other arm of the lever, therefore, rises, bringing the poles of the horse-shoe magnet closer to the poles of the two bar-magnets, and increases the attraction between them, which is a force acting in the same direction as gravity. The pendulum consequently moves faster (for we increase the pull upon it), the tendency to go slow arising from the increased atmospheric pressure is by this means compensated. Dr. Robinson, at the Armagh Observatory, effected the same correction by attaching a barometer to the pendulum rod. He also noticed that changes in atmospheric pressure would disturb a mercurial pendulum to a very considerable extent if there were air-bubbles in the mercury.

(*To be continued.*)

CROOKES'S RADIOMETER

I HAVE recently made a few experiments with this instrument which may not be uninteresting to the readers of NATURE.

The radiometer used had discs of aluminium polished on one side and blackened on the other; it was more than usually sensitive, and would sometimes continue its rotation for twenty minutes after the sun had set in the sea.

The instrument being in a room in which the radiation was far too feeble to cause the arms to move, I grasped the bulb with both hands, so as still further to exclude it from light. The vanes immediately began to revolve briskly, the polished sides first. Removing my hands after two or three minutes, the movement soon stopped; and then, after a very brief interval of rest, began in the opposite direction, and so continued for several minutes.

I now placed the instrument in a room, near to a window through which the light of the full moon in a clear atmosphere was shining. The arms of the radiometer did not move. By means of a large lens the moonlight was then concentrated about 200 times, and allowed to fall full upon the blackened side of one of the circular discs, in such a way as to cause the intensely brilliant image of the moon to nearly cover the disc. Not the slightest movement occurred, although the concentrated light impinged upon the disc for a quarter of an hour.

As is well known, the light of the moon contains, for a given luminosity, far less heat rays than does light from any terrestrial source, no matter how much the latter may be strained through intranscalent media; in fact it require Lord Rosse's 6-feet reflector clearly to demonstrate the excessively feeble thermal power of the lunar rays.

These experiments show, firstly, that light is not necessary to the movement of the radiometer; secondly, that light only contributes to the movement in so far as, by its absorption, it is transformed into heat; and thirdly, that the motion is due to the unequal heating of the two sides of the discs, the cooler surfaces always preceding the warmer; for when the instrument was grasped by the hands, the blackened surfaces of the discs rapidly absorbed the heat rays, whilst the polished surfaces reflected them. Thus the surfaces of the blackened discs remained warmer than the metal beneath, but gradually communicated their heat to the latter. On removing the hands from the bulb, the thermal condition of the discs would soon become reversed; the black surface—a good absorber and also a good radiator—would cool much faster than the opposite surface, which being of polished metal was an exceedingly bad radiator.

The blackened surfaces, therefore, now became the coolest, and preceded the polished ones, in other words, the direction of rotation became reversed.

October 17 E. FRANKLAND

THE GEOLOGY OF ENGLAND AND WALES[1]

THE well-known volume of Conybeare and Phillips, entitled "Outlines of the Geology of England and Wales," which was published in 1822, and was based on an earlier and slighter work of the second-named author, has long held an honourable place among geological classics. It has served, indeed, to supply to some extent the want so universally felt of a descriptive memoir or handbook to William Smith's Geological Map, a work which "the father of English geology" could never be prevailed upon to write himself. The "Outlines," however, is but a fragment, the second part of the work, which was to have dealt with the oldest rocks and with questions of Economic Geology, never having been published; and more than half-a-century of research, carried on in connection with a science which appears to have as

[1] "The Geology of England and Wales: a Concise Account of the Lithological Characters, Leading Fossils, and Economic Products of the Rocks; with Notes on the Physical Features of the Country By Horace B. Woodward, F.G.S., of the Geological Survey of England and Wales. (London: Longmans, Green, and Co, 1876)

yet lost none of the vigour and elasticity of youth, have of course rendered much of the information contained in it obsolete. The only work of more recent date which occupies somewhat the same ground is D'Archaic's "Histoire des Progrès de la Géologie," which aimed at doing for all those portions of the globe which had been geologically explored, what Conybeare and Phillips had attempted for England alone. This work is one of the very highest order of merit; its author being equally distinguished for his industry in the compilation of materials, his skill in arranging them, and his boldness and originality in generalising from them. But such a design as that of the "Histoire des Progrès" was perhaps too ambitious to be within the compass of the efforts of any single individual; at all events, after the portions relating to the Tertiary and Secondary strata had appeared in a series of eight volumes, between the years 1847 and '60, the work, which had up to that time been published by the Geological Society of France under the auspices of the Minister of Public Instruction, was finally abandoned.

It will be seen, therefore, that Mr. Woodward's handy volume, the title of which is given above, appears very opportunely; and, supplying as it does a real need of the geological student at the present time, it is certain at once to take its place as the most useful general work of reference on English Geology which exists. After a careful perusal of it, we find scarcely anything calling for qualification of those terms of high commendation in which we are constrained to speak of its general accuracy and excellence of arrangement; of the happy way in which the mean has been hit between conciseness of description and fulness of detail; and of the manner in which the work has been made to include the latest results of geological research.

At the time when Conybeare and Phillips wrote, many portions even of those Secondary strata of England, the successful classification of which had been the chief among

FIG. 1.—The Cheddar Cliffs.

the triumphs of William Smith's genius, were as yet almost unknown to geologists; the labours of Sedgwick and Murchison, which were destined to replace the confusion that reigned among all the older deposits, by the clear succession of the Cambrian, Silurian, and Devonian systems, had not then commenced; and as yet the palæontological studies of Lyell and the stratigraphical researches of Prestwich had not dispelled the almost equal obscurity which prevailed concerning the order of the Tertiary formations. There are perhaps few ways in which the strides made during the last fifty years in our knowledge of the geology of this country can be more vividly realised than by a comparison of the sketch-maps prefixed to the volume of Conybeare and Phillips, and to that of Mr. Woodward respectively. Such a comparison will render strikingly apparent the great advances which have been made in developing the true structure of the country, both through the researches of private individuals and the labours of the National Survey; and it will equally serve to demonstrate the necessity of such a work as that which Mr. Woodward has now given to us.

The avoidance by the author of this work of all references to the equivalent formations on the continent of Europe, or even to those in other parts of the British Islands—although perhaps a necessity dictated by the limits he had set himself—creates some serious difficulties, which are more especially felt when questions of classification come to be treated of. It is altogether vain to hope that such problems can be decided by an appeal to the English representatives of the formations alone. To discuss, for example, the question of the classification of the Silurian, Devonian, and Permo-Triassic (Poikilitic) formations, without any reference to the typical developments of these strata in Bohemia, the Eifel, and Central Germany respectively, is surely a most unsatisfactory and inconclusive proceeding.

In adopting Sedgwick's classification of the Cambrian and Silurian strata instead of that of Murchison, the

FIG. 2.—Purbeck and Portland Beds at Tilly Whim, near Swanage; the former being the light-coloured strata above, the latter the darker strata below.

FIG. 3.—Section at Writtle, near Chelmsford.—2. Chalky Boulder Clay (Upper Glacial). 1. Sand and Gravel (Middle Glacial).

FIG. 4.—Penrhyn Slate Quarry.

author may possibly have been actuated by the conviction that unless the pendulum of opinion, which has so long been firmly held at one end of the arc by official influences, were allowed to rebound to the extreme limit in the opposite direction, there would be little chance of its finally attaining a position of stable equilibrium between them. Looked at from any other point of view, we must confess that we cannot regard the attempt here made totally to revolutionise the classification in question with much satisfaction. We had hoped that the day had long since gone by when the divisions between geological periods were to be regarded as governed by anything more than convention, or as serving any other purpose than that of convenience of reference. Breaks, whether stratigraphical or palæontological, in the series of formations, are *purely local phenomena;* and it is certain that if stratigraphical geology had taken its rise only so far away as in Eastern instead of in Western Europe, the divisions of the great systems, and even of those larger periods (which Mr. Woodward calls "cycles") would have been wholly different to that which has been actually adopted. But although the classification of the geological periods is a purely artificial one, yet it has its uses, and nothing but confusion can result from attempts to unsettle its landmarks without sufficient cause. Such being the case, we are surely entitled to ask what useful purpose can possibly be served by including, as our author does by his own showing, considerably more than one-third of the whole thickness of British sedimentary deposits under the name of Cambrian? Is not a Cambrian system, enlarged beyond all reasonable proportions, equally objectionable with an overgrown Silurian? This question has passed beyond the stage when it can be regarded simply as a battle-ground for the partisans of rival reputations. Now that Sedgwick and Murchison have both passed away, let us rather seek to be guided by the principles which determined the action of the greatest of their contemporaries in respect to this controversy; gladly availing ourselves of that which is good and true in the splendid work of both the observers, let us build it into our geological system, there to stand as the noblest monument of their genius; and for their mistakes, let these pass into the oblivion which awaits the memory of the injustice and animosity which were unworthy of either of them.

There are one or two other points which we would venture to suggest for the author's consideration in the event of his being called upon, as we hope he will be, to prepare a second edition of this work. As the different formations or groups of strata belonging to the same system which occur in different parts of the country are treated of consecutively, although in many cases they were doubtless formed contemporaneously, it would be well to keep the latter fact as prominently before the

mind of the student as possible; and this, we think, might best be accomplished by prefixing to each chapter diagrammatic sections of the succession of strata, exhibiting their equivalences in different parts of the country. Again, although we recognise with the author the impossibility of quoting in such a work as the present the authority for every statement, yet we think that a well selected series of references to those original memoirs, in which fuller details concerning each formation may be found, would greatly add to the value of the book without materially increasing its bulk.

We cannot but commend the manner in which Mr. Woodward has resisted all attempts at fine writing, and has sought rather to produce a work characterised by accuracy and soundness than by showiness and superficiality; in this respect following the example of his father, the late Dr. Samuel Woodward, to whose memory the work is dedicated. We anticipate for the "Geology of England and Wales" a sphere of usefulness not less extended than, and a reputation as enduring as that which has been attained by, the "Manual of the Mollusca;" and higher praise it would scarcely be possible to award to it.

It only remains to add that the work is illustrated, not only with a very clear chromo-lithographed map prepared by Mr. Griesbach, but by woodcuts of such excellence (as will be manifest from the specimens we give of them) that we can only regret that they are so few in number.

J. W. J.

SUMNER'S "METHOD AT SEA"

IN reference to our review of Sir William Thomson's work on this subject (vol. xiv. p. 346), our attention has been called by Sir G. B. Airy to the following paper in the *Proceedings* of the Royal Society, vol. xix. p. 448:—

"Remarks on the Determination of a Ship's Place at Sea." In a Letter to Prof. Stokes. By G. B. Airy, LL.D., &c., Astronomer-Royal.

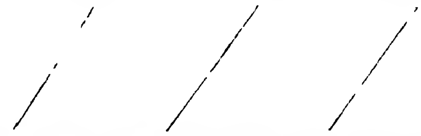
Royal Observatory, Greenwich, S.E., 1871, April 5.

MY DEAR SIR,—In the last published number of the *Proceedings* of the Royal Society (vol. xix. p. 259), there are remarks by Sir William Thomson on the proposed method for determining the *locus* of a ship's place at sea, by making one observation of the sun's (or other body's) altitude, and founding, on this, computations of longitude with two assumptions of latitude; and there are suggestions, with a specimen of tables, for solving the spherical triangles which occur in all similar nautical observations, on the principle of drawing a perpendicular arc of great circle from one angle of a spherical triangle upon the opposite side.

In regard to this principle and the tables which may be used with it, I may call attention to the employment of a similar method by Major-General Shortrede, in his "Latitude and Declination Tables," pp. 148 and 180. In p. 150, line 11 from the bottom, it will be seen that the "column" gives the trial-value of the perpendicular arc by which the two right-angled triangles are computed. This is not the same (among the various elements which may be chosen) as Sir William Thomson's; but it is so closely related that in some instances the tabular numbers are identically the same as Sir W. Thomson's, though in a different order. General Shortrede's object was "Great Circle Sailing," in which the trigonometrical problem is the same as in the nautical observation. I think, however, that Sir W. Thomson deserves thanks for calling attention to the application of this method to time-determinations.

In regard to the problem of the "locus," allow me to point out the geometrical circumstances of the case. If, upon a celestial globe, an arc of small circle be swept with the sun's (or other body's) place for centre, and the observed zenith-distance for radius, the ship's zenith will be somewhere in that curve; and if, with the pole for centre, arcs of parallels be swept with the two assumed colatitudes for radii, the intersection of these two curves with the first drawn curve will give the ship's zenith on the two assumptions; and if within the celestial globe there be placed a small terrestrial globe, and if these zenith-points be radially projected upon the terrestrial globe, the terrestrial places of the ship on the two assumptions will be marked. But the practical application of this requires that the position of the terrestrial globe, or of the earth, be known in respect of rotation—that is, it requires that the Greenwich sidereal time, or solar time, be known; in other words, it requires a perfect chronometer. Now the experience of Capt. Moriarty, cited by Sir W. Thomson, does not apply here. Capt. Moriarty received time-signals from the Royal Observatory through the cable every day, and he had therefore a perfect chronometer. But other ships have no such perfect chronometer; and though the *direction* of a *locus*, as determined above, may be sufficiently certain, yet its *place upon the earth* will be uncertain, by a quantity depending on the uncertainty of the chronometer. Thus three chronometers may give the following positions for the locus-curve:—

Chron. No. 1. Chron No 2. Chron. No. 3.



And the question now presents itself, which uncertainty is the greater—the uncertainty of latitude, which it is the real object of this problem to remedy? or the uncertainty of the chronometric longitude, which must be used in attempting to find the remedy? I do not doubt the instant reply of any practical navigator, that the chronometric longitude is far more uncertain than the latitude; and if it be so, the whole method falls to the ground.

I fear that a publication like that which has been given to this method may do very great injury among navigators who are not accustomed to investigate the geometrical bearings of such operations, and may lead them into serious danger.

I am, my dear Sir, yours very truly,

G. B. AIRY.

Prof. Stokes, Secretary of the Royal Society.

[From a general recollection of a conversation I had with Sir W. Thomson before the presentation of his paper, I do not imagine his object to have been exactly what the Astronomer-Royal here describes, but partly the saving of trouble in numerical calculation, partly the exhibition, for each separate observation of altitude at a noted chronometer time, of *precisely what that observation gives, neither more nor less*, which introduces at the same time certain facilities for the determination of a ship's place by a combination of two observations. Of course the place so determined is liable to an error east or west corresponding to the unknown error of the chronometer; and doubtless, under ordinary circumstances, this forms the principal error to which the determination of a ship's place is liable. This remains precisely as it did before; and it is hard to suppose that the mere substitution of a graphical for a purely numerical process could lead a navigator to forget that he is dependent upon his chronometer, though perhaps the general tone of Sir W. Thomson's paper might render an explicit warning desirable, such as that which Mr. Airy supplies.—G. G. STOKES.]

NOTES

WE hear with sincere regret of the death of the eminent French meteorologist, M. Charles Sainte-Claire Deville. We hope next week to give some details of his life and work.

WE publish on another page an abstract of the Rev. Mark Pattison's forcible and outspoken address at the Social Science Congress, Liverpool, on the state of our universities. Many other valuable papers were read, but they were for the most part too special for notice in our columns. We should, however, mention the remarks of Mr. W. H. James, M.P., in connection with the discussion of the question of incorporating a professional and technical training with a sound system of general education. Mr. James traced the history of the City Guilds of London, showed how enormously wealthy they must be, how this wealth is totally misspent, and maintained that the country had a perfect right to ask an account of their stewardship, and appropriate the funds, if necessary, for educational purposes. He proposed that

the funds should be devoted to the establishment of a science and practice institute for working men. All the speakers in the Education department of the Congress seem to be agreed that there is vast room and urgent need for improvement in the education of the country. When so many intelligent and influential men are agreed on this point, how is it so little is done to mend matters? After the reading of a paper on Tuesday by Mr. W. J. Watts on the proposed Imperial Museum for India and the Colonies, a proposal was unanimously adopted by the Section of Economy and Trade, "that the Section recommend the Council to consider the propriety of memorialising her Majesty's Government in favour of establishing an Imperial Museum for India and the Colonies in London, and, if possible, with special arrangements for loan collections." In connection with the meeting of the Social Science Congress, at Liverpool, the *Liverpool Albion* has published a series of articles on the progress, present condition, and the great men born in that town. These have now been reprinted in a neat little pamphlet.

SOME account of Mr. Giles's trans-Australian journey has reached this country; he arrived in South Australia in August. Mr. Giles, who started on April 10 from a spot 27° 7′ South latitude and 116° 45′ East longitude, says:—"I made a generally north-east by east course by way of Mount Gould, in latitude 26·46, till the 24th parallel was reached. I traced the Ashburton to its sources, and determined the old watershed by the western rivers, which is simply a mass of rangy country abutting upon the desert in longitude 120° 20′. From the depot on the Ashburton I went up to the 23rd parallel. No watercourses flowed eastward. From the end of the watershed in that longitude, the latitude being near the 24th parallel, to the Rawlinson Range of my last horse expedition, in longitude 127°, the country was all open spinifex sandhill desert. At starting into the desert most of the camels were continually poisoned, the plant which poisoned them not being allied in any way to the poison plants of the settled districts of Western Australia. I now know it well, and have brought specimens. The longest stretch without water was a ten days' march. One old cow camel died after reaching the water. We had some rain on May 8 before reaching the Ashburton, and some of it must have extended into the desert. It was the only chance water we obtained. We had some more rain north of the Alfred and Mary ranges. Portions of the Rawlinson and Petermann ranges had been visited by rains, but the further we went eastward the more desolated with drought the country became. We struck the telegraph line at the angle poles close to Mount Halloran, on the Neal's River, sixty miles from the Peake, and travelled thence down the line to the station. We were all attacked with ophthalmia before the rains fell in May. The winter was excessively cold, the thermometer in the morning for weeks being down to 18°. No natives were met with from Mount Gould to the Petermann Ranges, at which last-named place they were friendly. In Musgrove Range they stole a few things, but I was absent at the time. The camels have travelled splendidly."

A MUSHROOM Exhibition will be opened on the 23rd inst. at the rooms of the French Botanical Society, 84 rue de Grenelle, Paris, which is likely to be of interest both from a scientific and an economical point of view. It is proposed to bring together all species of mushrooms, either in a fresh or a dry state, eatable, poisonous, hurtful to agriculture, as well as books, drawings, and engravings bearing on the subject. The exhibition will last eight days, during which there will be suitable lectures, as well as excursions to the neighbourhood of Paris. The following questions are proposed by the Society:—1. On the development of the reproductive organs of mushrooms; what is the exact signification of the terms *spores, chlamydospores, stylospores, conidia, spermatia*, &c. 2. Fungoid protoplasm compared with that of the vegetable chlorophylls. 3. On the classification of the *Agarici*, and generally the relative value of characteristics among mushrooms. 4. Study of the substrata necessary to the development of various fungoid species and of the relation which exists between the substrata and these species; questions relative to parasitism. 5. On edible mushrooms in various regions. 6. The necessity of encouraging chemical investigation on mushrooms; a *résumé* of the facts ascertained in this department to the present time. 7. The best processes for preserving mushrooms for study. 8. Bibliographical researches on the mycologists of last century.

A TASHKEND telegram of October 6 announces that the scientific staff of General Skobeleff's Alai Expedition have accomplished their work most successfully. The Alai and Trans-Alai mountains and the northern part of the Pamir plateau were surveyed along the routes followed, and astronomical determinations of latitude and longitude made. The highest spot, where astronomical observations were made, was at a height of 14,500 feet, and is in the part of Pamir called Khorgota. The height of the Oos-Bel pass was 15,500 feet. Measurements of the magnetic declination were also made on the Pamir plateau, and valuable collections brought home. The map of the Alai, plotted by Dr. Petermann on the basis of the surveys and descriptions of the late M. Fedchenko, proved to be very satisfactory.

THE congress of the International Geodesical Association, established by several European governments, was held this year at Brussels, and will be held in 1877 at Stuttgart. For a number of years the French Government abstained from sending delegates, but they were represented this year by M. Faye, M. Yvon Villarceau, and Major Perrier, director of the French Survey. The president was General Ibanez, the Spanish delegate. Switzerland was represented by M. Hirsh, Prussia by General von Baeyer, Austria by Oppolzer, Belgium by Major Adan, Saxony by M. Bruhm, Russia by General de Forsh. Neither England nor the United States sent any delegates. A report was presented by Major Adan on the registering meteorological instruments established at Ostend by Prof. Rysselberghe, of the Ostend Navigation School. These instruments, which obtained an exceptional reward at the International Geographical Exhibition at Paris in 1874, were praised in very warm terms. It is said that they will be used at a number of maritime stations for registering the tides. On the proposition of General Ibanez a requisition is to be sent to the French Government asking them to take the necessary steps for joining the French and the Spanish triangulations.

WE are glad to be able to state, at the request of the Hon. W. B. D. Mantell, of the New Zealand Legislative Council that he has publicly repudiated the contemptuous words in reference to scientific men attributed to him in NATURE, vol. xiv. p. 90. Such a statement, he says, would be an act of "gross and insane ingratitude" towards many men whom he is proud to call his friends. He was speaking only of "the shams and Dousterswivels of science," for nobody could have a greater or more devoted esteem for scientific men than he had. He was perfectly serious in proposing that an inquiry should be made in reference to the discovery of the skeleton referred to.

DR. MCKENDRICK has been appointed to the Chair of Physiology in the University of Glasgow.

THE Fellows of the College of Physicians of Dublin have deliberately determined to admit Miss Edith Pechey to the examination for the L.K.Q.C.P.I., and have thus thrown open the portals of the medical profession to all comers, whether they be "persons" of the male or female sex. However pregnant of results this decision may be, says the *Medical Press and Circular*, it does not

seem to us that any other conclusion was possible, and we expect to see a similar ingress allowed to the ladies by all other bodies. The Queen's University, it is anticipated, will be the next to follow suit, and these fortresses having surrendered at discretion, it is impossible that others can long sustain the siege.

A REPORT that Mr. Lucas, the African traveller, had given up exploration in consequence of illness is unfounded. Mr. Lucas had an attack of fever, but is now at Cairo waiting for stores which have been ordered from England, on the arrival of which he will proceed by steamer to Zanzibar, and again make for the interior. Mr. Lucas is in communication with the Royal Geographical Society.

MRS. NASSAU SENIOR writes to the *Times* on the curious behaviour of tempered glass. She furnished twelve gas burners with tempered glass globes purchased in London, and having the veritable label of M. de la Bastie affixed to each. On the night of the 6th inst. after the gas had been extinguished for exactly an hour, one of the globes burst with a report and fell in pieces on the floor, leaving the bottom ring still on the burner. These pieces, which were, of course, found to be perfectly cold, were some two or three inches long, and an inch or so wide. They continued for an hour or more splitting up and subdividing themselves into smaller and still smaller fragments, each split being accompanied by a slight report, until at length there was not a fragment larger than a hazel nut, and the greater part of the glass was in pieces of about the size of a pea, and of a crystalline form. In the morning it was found that the rim had fallen from the burner to the floor in atoms. The subject deserves careful investigation.

THE Science Loan Exhibition has been so successful that the time for closing it has been postponed, and the evening lectures are to be recommenced immediately.

WE have received *Études sur les Mouvements de l'Atmosphère*, Part 1, by Professors C. M. Guldberg and H. Mohn, of Christiania. In this first part of what promises to be an important contribution to the physics of the atmosphere, the authors confine the discussion to some simple elementary cases of the mechanics of the atmosphere relative to its equilibrium, temperature, humidity, and horizontal and vertical currents. We join the authors in hoping that the results will demonstrate the necessity of more extensive observations than have yet been made in tropical regions, and in the higher regions of the atmosphere on mountains or by captive balloons, and that the true path of progress for meteorology to follow is the development of the difficult question of atmospheric mechanics. We may add that in order to obtain the physical data required for its discussion, the only rational step to be first taken is to plant numerous meteorological stations over limited areas, the stations being so closely planted as to secure approximations to the barometric gradients between the observing stations and to the wind-velocities, sufficiently close to the true gradients and velocities as to meet the demands of the problem to be investigated.

THE teaching body of the French National School of Agriculture, established at the Conservatoire des Arts-et-Metiers, has now been organised. The director of studies is M. Boussingault, the founder of agricultural chemistry in France. The number of professorships is twenty, and a competition will take place for three of them. Amongst the seventeen others who have been appointed by decree, M. Lavergne, Professor of Agricultural Economy, M. Leon Bocquerelle, Professor of Physics and Meteorology, and M. Tany, Professor of Sylviculture, were formerly professors at the Versailles School of National Agriculture, which was suppressed in 1852. The former imperial farmhouse at Vincennes will be utilised for experimental agriculture. Amongst the professorships which have been created ought to be noticed one of Comparative Agriculture, or the systematic comparison of French and foreign agriculture.

M. WADDINGTON, the French Minister of Public Instruction, has published a circular warning the several municipal administrations of France, that he is to ask from Parliament next session a credit for increasing the salaries of professors who, having not taken any superior degree, are nevertheless useful and steady workers. But he desires the cities to enter into an agreement with the Government to secure to competent teachers in the several municipal secondary schools a rate of remuneration not below a sum named. It is only when that rate shall have been granted as a permanency by the local authorities that the Government will give any addition.

M. WADDINGTON is said to be preparing to present to both Houses of the French Parliament a Bill to alter the law for granting degrees, giving the power entirely to the State examiners. The same proposal was rejected by the Senate last spring.

A NEW municipal school, the École Monge, was opened at Paris on October 8. The peculiarity of the establishment is a covered yard situated in the centre of the building, and occupying a space of 18,000 square feet for winter recreations. When the weather is favourable, the pupils are turned into an open ground of 27,000 square feet. A portico for gymnastics has been erected in the winter grounds. To each studio is annexed a small museum, so that pupils may have constantly at their disposal the principal objects or models which are described in the course of the lectures given by the teachers. The school is intended for 800 pupils, but only 500 have been admitted, a part of the work being yet unfinished.

THE *Tarbes Observeur* states that a strong earthquake was felt at Bagnères de Bizarre (Hautes Pyrenees) on Friday, October 6, at five in the morning. The water of Salies, a thermal spring in the vicinity, which generally flows at 59° F., had its temperature suddenly altered to 72°, owing to the subterranean action. A few hours afterwards the same commotion was felt by General Nansouty, who has taken his post as observer on the Pic du Midi. The duration was three seconds, and direction south by north.

ON September 22, an earthquake motion was felt at Corleone, near Palermo, and from that time to September 27, seismic commotions were almost continuous. Great damage has been done to a large number of houses, and the inhabitants desert the city every night and encamp in the vicinity; cold is becoming intense during the now long nights. Some are said to have turned insane.

MESSRS. C. G. MAYNARD, of Newtonville, Massachusetts, and W. F. Parker, of West Meriden, Connecticut, are about to undertake an investigation of the natural history of the Bahama Islands, which promises to be of great interest to science in view of the fact that, with the exception of the examination made by Dr. Henry Bryant, of Boston, U.S., but little has been done in this respect since the time of Catesby, whose work was published nearly 150 years ago. These gentlemen propose to fit out a yacht in Boston, suitably equipped and provisioned, and send her to the Gulf of Mexico, there to embark some time in the present month, and to make a minute investigation of the natural history of each island, obtaining specimens of its land fauna and of the inhabitants of the waters along their shores. They will be accompanied by several assistants, and hope to make very large collections of all kinds. Dr. Lewis E. Sturtevant, of Boston, will accompany the expedition for the purpose especially of assisting Mr. Maynard in making drawings and dissections on the spot of the various animals.

A NAVAL testimonial will be presented to Commander V. L. Cameron, R.N., C.B., at the Royal United Service Institution,

on Saturday, at 3 o'clock. Admiral Sir G. P. Sartorius will preside.

PROF. W. K. PARKER, F.R.S., and Mr. G. T. Bettany, B.A., of Caius College, Cambridge, are preparing a work on the Morphology of the Skull, in which for the first time will be brought together for comparison descriptions of the remarkable succession of modification through which the skull passes in development in the principal types of vertebrated animals; the forms illustrated will be the sharks and rays, the salmon, the axolotl, the frog, the snake, the fowl, and the pig. A special value will attach to the work inasmuch as it will record many corrections of facts and important modifications of view since the publication of Prof. Parker's elaborate papers in the *Transactions* of various societies, and will also include many observations yet unpublished. A simple description of each form at successive stages will be followed by a chapter dealing with theoretical questions, and summarising the results of study. The work will be illustrated by a large number of woodcuts, and will be published by Messrs. Macmillan.

THE scintillation of stars, and its close connection with changes of weather, has, as is known, much interested Humboldt, Arago, Kaemtz, Secchi, and many others; and recently it has also been the subject of valuable spectroscopic researches by M. Respighi. M. Montigny, who some time ago investigated scintillation in relation to the special characteristics of the light of different stars, publishes in the *Bulletin* of the Belgian Academy, 1876, No. 8, an elaborate report upon his researches into the connection existing between scintillation and various meteorological elements. The chief results arrived at after a discussion of 1,820 observations made on 230 days on 70 different stars, are as follow:—The intensity of scintillation (measured by a special apparatus, the scintillomètre) increases invariably with the occurrence or approach of rainy weather, and with the increase of tension of vapour in the air on one side, and the increase of pressure and decrease of temperature on the other; the influence of the two former factors being far more sensible than the combined influence of the two latter. The scintillation, which is on an average stronger during winter than during summer, increases with the arrival of moist weather at all seasons. It increases also not only on rainy days, but one or two days before, decreasing immediately after the rain has ceased. Moreover, the intensity of scintillation increases during strong winds, and with the approach of barometric depressions, or *bourrasques*, the increase being most pronounced when the depression passes near to the observer. It then largely exceeds the average increase corresponding to rainy days, and the influence of great movements in the atmosphere totally counteracts the contrary influence of a lowering of pressure. M. Montigny is thus correct in saying that a continued investigation of scintillation would be of great service, not only for the prevision of weather, but also for the general study of meteorology, affording a very useful means for the exploration of the higher regions of the atmosphere.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, presented by Mr. Henry S. Wright; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. H. Jones; a Little Grebe (*Podiceps minor*), European, presented by Mrs. Johnson; two Snowy Owls (*Nyctea nivea*), European, presented by Mr. L. W. Gardiner; nine Red-bellied Newts (*Triton alpestris*) from Tyrol, presented by Mr. P. L. Sclater, F.R.S.; a Tamandua Ant-eater (*Tamandua tetradactyla*) from South America, purchased: an Ocelot (*Felis pardalis*) from America, two Indian Cobras (*Naia tripudians*) from India, deposited; a Geoffroy's Dove (*Peristera geoffroii*) bred in the Gardens.

SCIENTIFIC SERIALS

Journal of the Chemical Society, July, 1876.—Mr. Thomas Carnelley, B.Sc., communicates the results of investigations recently made by him, on the action of water and of various saline solutions on copper. Mr. Carnelley has found that distilled water dissolves an appreciable amount of copper, on standing in contact with the metal even for the comparatively short space of an hour.—Mr. M. M. Pattison Muir, F.R.S.E., gives the second part of a paper on certain bismuth compounds. There are also two communications from Dr. Thudicum's Physiological Laboratory. The first is by Dr. Thudicum and C. T. Kingzett, on glycerophosphoric acid and its salts, as obtained from the phosphorised constituents of the brain. The second is by Dr. Thudicum, on some reactions of biliverdin. There are besides a note on the occurrence of benzene in rosin light oils, by Mr. Watson Smith, F.C.S., and a second paper by the same gentleman on a new method of preparing diphenyl and isodinaphthyl, and on the action at a high temperature, of metallic chlorides on certain hydrocarbons.

Gazzetta Chimica Italiana, Fasc. v. and vi.—The following papers comprise the contents of this number:—The inactive amylic alcohol of fermentation, by L. Balbiano.—An alkaloid which they found in spoiled Indian corn and in stale maize bread, by T. Brugnatelli and E. Zenoni. The authors consider this alkaloid to be the cause of "pellagra," a disease which commits great ravages in Lombardy.—Concerning a series of compounds derived from ammonaldehyde, by R. Schiff.—On gelatine, considered especially as regards its reducing agency, by G. Bizio.—On the emission of nascent hydrogen from vegetables, by G. Pollacci.—G. Scurati Manzoni contributes two papers; the first, on the action of certain reagents upon the principal organic colouring matters, is accompanied with extensive tables, which contain much valuable information; the second treats of the employment of sodic hydrosulphite as a reagent in the analysis of the colours fixed upon tissues.—On the natural poison of the human body, by A. Moriggia.—Concerning the methods of preparing the iodides of potassium and sodium, and of potassic bromide, by P. Chiappe and O. Malesci.—Observations on a process for obtaining iodic acid, by causing chlorine to act upon iodine suspended in water, by G. Sodini.—On the precipitate of sulphur, by M. Sansoni and G. Cappellini.—A method for detecting the adulteration of plumbic iodide, by L. Alessandri and C. Conti.—A new reagent for the investigation and estimation of glucose, by A. Soldaini.

Memoria della Società degli Spettrocopisti Italiani, May, 1876.—Prof. Tacchini gives the statistics of solar eruptions observed at Palermo in 1872. In 134 days of observation fifty-two eruptions were seen—twenty-four on the eastern limb and twenty-eight on the western, and none apparently occur within 40° of either pole. There also appears a detailed statement by Prof. Tacchini of the positions on which magnesium was seen on the limb during the months of August, September, and October, 1875.—Observations of the partial eclipse of the sun on September 29, 1875, made at Padua by Dr. Abetti.—Spots and faculæ on the sun's limb, observed at Palermo; the lines seen bright in the spectrum of the jets are b^1 b^2 b^3 b^4, 1474, 4923, 5017, and sodium lines. A sheet showing the chromosphere on each day in August, 1874, accompanies this number.

June, 1876.—Observations of spots and faculæ made at Palermo in May, 1876, with a table showing the numbers of positions at which the b and 1874 line were visible at the limb.—Observations of solar protuberances from June 29 to December 11, 1875, showing the number in each 10° of the sun's circumference, their heights, and area.—A note by Father Secchi on the change of position of the lines in the spectra of stars caused by their movement in space. In his experiments the author placed the vacuum tube for comparison in front of the object-glass, and he and his assistants found the stellar and tube lines could be made to change places by the motion of the telescope, and that the results by this method are not trustworthy. The author then gives a list of stars with their motions as given by Huggins, Greenwich, Secchi, and Vogel, showing a great discrepancy between the observers.—On the observation of the zodiacal light, made by Rev. Geo. Jones, from April, 1853 to April, 1855, by A. Serpieri. About thirty-nine observations with the lat. and long. of the place of the observer appear, together with other tables of the positions of the light, and a lengthy paper of remarks on the same. Drawings of the chromosphere for September, October, and November, 1874, accompany the number.

July, 1876, commences with a continuation of A. Serpieri's paper on the observation of the zodiacal light, by G. Jones.—Father Secchi contributes a second note on the change of position of the lines in stellar spectra due to the motion of the stars. The author in this, as in the last note, throws doubt on the reliability of the method in practice.—Observations of solar protuberances made during the first half of the present year at Rome. This consists of a table showing the number of prominences seen on each 10° of solar circumference, the height, size, and area of the prominences, and the extension of faculæ.—Spectroscopic and direct observations made at Palermo in the months of June and July. This paper includes a table showing the number of spots and faculæ on each day, with notes of the positions in which the *b* and 1474 lines were seen.

August, 1876, contains three papers by Prof. Ricco, the first of considerable length, on the absorption spectrum of water, with a plate showing the method of experiment and the spectrum of sea-water seen; the second on the spectral study of the green of plants; and the third on a new form of direct-vision spectroscope. In this new form the rays of light from the collimator pass through a prism of 60° in the ordinary way; they then fall on the side of a prism of 90°, having its base nearly in the same plane as that of the first; they are thus totally reflected internally from the base of the prism, and emerge from the other face parallel to their original position.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. April—July.—A controversy which has been going on between M. Lombroso and a Committee of the Institute as to the poisonous properties of decayed maize and the disease of pellagra (in Northern Italy) is referred to here.—In the treatment of vines with sulphur for oidium, the destruction of the parasite has been shown to be due to formation of sulphydric acid. Whether the necessary hydrogen came from the oidium or from the grapes was uncertain, till it appeared that grapes that were quite free from the disease, gave sulphuretted hydrogen when sprinkled with sulphur. M. Selmi proved the development of nascent hydrogen from mould, and M. Polloni, having experimented on a number of plants, now sprinkled with sulphur, gave sulphydric acid. Most of it is produced in those parts in which the vegetation is most active (as the flowers and young buds). Plants with saccharine fruit (as the vine and mulberry) do not produce it in greater quantity than others. The author concludes from indirect experiments that all plants, in certain phases of their growth, and as the result of physiological acts, produce hydrogen *in the nascent state.*—A valuable paper of statistics and information regarding diphtheria in Milan, in the three years 1873, 1874, 1875, is contributed by Dr. Fellice Dell'Acqua. With reference to meteorological conditions, it is concluded that neither the maximum nor the minimum of air pressure, of temperature, of vapour tension and relative moisture, seemed to have the least influence in raising the number of cases of diphtheria. In winter and autumn the number of individuals taken ill was less, but the less number of deaths was in spring and summer.—M. Montegezza gives a careful analysis of the phenomena of expression of grief.—The course of storms is studied by M. Frisiani.—In biology we find notes on the nucleoli in the envelopes of some Protozoa, the mieline in Infusoria, the fresh-water Rhizopods of Lombardy.

Zeitschrift fur Wissenschaftliche Zoologie, vol. xxvii., Part 2.—Prof. Selenka opens this number with a very interesting contribution to the embryology of the Holothurians, accompanied by beautiful figures. He describes the early stages of *Holothuria tubulosa* and *Cucumaria doliolum*. Among his conclusions may be mentioned the following:—The mesoderm arises entirely out of the entoderm; the mesoderm gives off motile cells from which the subcutaneous circular muscles, the primary alimentary canal, and parts of the internal skeleton are formed; the first-named species undergoes complete, the second incomplete metamorphosis; the transformation of Echinoderm larvæ can only be regarded as metamorphosis, not as alternation of generations.—Prof. Salensky, of Kasan, contributes a monograph of the development of *Salpa democratica*, from fecundation to the establishment of all the organs. At the conclusion of his paper he discusses the evidence which embryology affords as to the true position of the Salpæ. He shows that they lack the provisional organs as well as the mantle and foot, found in all mollusca. The cellulose test is in no way homologous with the molluscan mantle. The respiratory cavity is simply a differentiated part of the alimentary canal. The author considers the Vermes also to be nearer the Mollusca than the Salpæ, by reason of the provisional organs of many of their embryos. He emphasises the differences between the development of the Salpæ and the Ascidians, and, allowing that the viviparous reproduction of the Salpæ may account for much, he thinks that we are still considerably in the dark on the matter. He makes no allusion to the hypothesis that the Iunicata may be degenerate Vertebrates.—Ernst Zeller gives an account of the anatomy and life history of *Polystomum integerrimum*, a Nematode worm which inhabits the urinary bladder of frogs in its adult condition, and is found in the respiratory cavity of tadpoles during its larval state. Migration takes place through the alimentary canal of the host when the frog has undergone its metamorphosis; some individuals become sexual while in the respiratory cavity; these do not migrate, are short-lived, and do not appear to mature their eggs.

Gegenbaurs' Morphologisches Jahrbuch, vol. ii., Part 1.—Dr. von Ihering, of Göttingen, has an important article on Gasteropods, expounding the structure of the opisthobranchiate *Tethys leporina*, and making deductions equally unfavourable to the views of Prof. Huxley on morphology, and of Haeckel on phylogeny. He sees no ground for believing that the larval velum is the fore part of the epipodium, and expresses his astonishment that Prof. Huxley's paper on the morphology of the cephalous mollusca should be deemed authoritative. Haeckel's dogmatic system of phylogeny is stated to be not in accord with facts as regards the mollusca. The author believes that the prosobranchiate Gasteropods are derived from segmented worms, the opisthobranchiates from flat worms.—R. Hertwig endeavours to unify the differences in the structure, behaviour, and mode of formation of nuclei.—A brief contribution on the Cœlenterata, by G. v. Koch, is noticeable as describing a mesoderm in Halisarca.—Dr. W. Rolph has a long account of Amphioxus, increasing its abundant literature by nearly eighty pages, illustrated by three plates. He claims to have made it clear that its "body cavity," formed by the downgrowth of lateral lobes, is a respiratory cavity, homologous with the perivisceral chamber of ascidians, with the respiratory cavity of the tadpole, and the gill-cavity of symbranchii. He strongly objects to the identification of this chamber with the proper body-cavity of Vertebrata.

SOCIETIES AND ACADEMIES

London

Entomological Society, October 4.—Sir Sidney Smith Saunders, C.M.G., vice-president, in the chair.—M. Alfred Preudhomme de Borre, secretary of the Belgian Entomological Society, was elected a foreign member.—Mr. Bond exhibited varieties of *Hepialus humuli* and *Epunda lunulenta*, and also specimens of the new Tortrix (*Sericoris irriguana*), all taken near Loch Laggan by Mr. N. Cooke.—Mr. Forbes exhibited a weevil (evidently not indigenous to Britain) taken alive among some orchids at Highgate. Mr. Pascoe pronounced it to be a species of *Cholus*, a South American genus, for which he proposed the name of *C. Forbesii*.—Mr. W. Cole exhibited numerous bred specimens of *Eunomos angularia*, showing differences in coloration according as the larvæ had been fed on oak, hawthorn, lime, or lilac.—Mr. Enock exhibited microscopic slides containing some beautiful preparations of minute species of *Hymenoptera*.—Mr. Frederick Smith communicated "Descriptions of new species of Cryptoceridæ belonging to the genera *Cryptocerus*, *Meranoplus*, and *Cataulacus*," accompanied by figures of the several species. The author gave some interesting particulars relative to the habits of these insects, especially of *Meranoplus intrudens*, which constructs its formicarium in the thorns of a species of *Acacia*. These thorns were some 4 or 5 inches in length, and at a distance of about half an inch from the pointed end, a small round hole was made for ingress and egress to and from the nest. The thorns contained a kind of spongy pith in which the channels and chambers of the nest were constructed.—A catalogue of the British Hemiptera (Heteroptera and Homoptera) compiled by Messrs. J. W. Douglas and John Scott, published by the Society, was on the table.

Manchester

Literary and Philosophical Society, October 3.—Rev. William Gaskell in the chair.—On the action of water and saline solutions upon lead, Part 2, by M. M. Pattison Muir, F.R.S.E., Assistant Lecturer on Chemistry, Owens College. It appears

to be shown by Mr. Muir's experiments that the solvent action of dilute saline solution upon lead tends to attain a maximum when large surfaces of liquid are exposed to the surrounding air, and when the volume of liquid is large in proportion to the surface of lead exposed. Further, that under these conditions, and in the presence of those salts which aid the action—especially nitrates and more especially ammonium nitrate—the quantity of lead dissolved increases in an increasing ratio with the time during which the action is allowed to proceed.

PARIS

Academy of Sciences, October 9.—Vice-Admiral Paris in the chair. The following papers were read:—On the absorption of free nitrogen by the immediate principles of plants, under the influence of atmospheric electricity, by M. Berthelot. He used, this time, the weaker normal electric tension in the atmosphere. One closed tube of thin glass was inclosed in another. In the former was a roll of platinum joined to a conductor electrified by the atmosphere (at a height of 2 metres), while a thin sheet of tin round the outer tube was connected to earth. Into the annular space was (previously) introduced pure nitrogen or ordinary air, along with moist strips of blotting paper or a few drops of syrupy solution of dextrine. Twelve tube-systems, varying as described, were connected in position, from July 29 to October 5; the mean electric tension being that of 3½ Daniell elements, but oscillating from $+ 60 D$ to $- 180 D$. In all the tubes nitrogen was fixed by the organic matter—one to several millimetres per tube. In two cases green spots of microscopic algæ were found on the strips of moist paper in nitrogen tubes, showing a greater fixation of nitrogen in these. The experiments indicate an influence, little suspected hitherto, in vegetation.—Note on capillary affinity, by M. Chevreul. The name comprises all cases of union of a solid with a gas, a liquid, or a body held in solution by a liquid, where the solid retains its apparent form. The present note refers to action of massicot or calcined litharge on lime, strontium, or baryta water. The facts of capillary attraction are specially important for agriculture.—On the action which boric acid and the borates exert on plants, by M. Peligot. French beans watered once with solutions of borate of soda or potash, or boric acid, soon withered and died. He doubts if a substance so deleterious to plants can be quite innocuous to animals, where used to preserve meat.—On the reciprocal action of oxalic acid and monoatomic alcohols, by MM. Cahours and Demarçay. Where oxalic acid is caused to act on a mixture of propylic and isopropylic alcohols, propylic oxalate is produced almost exclusively. If the corresponding alcohols be extracted from this mixture of oxalates by saponification, a mixture rich in propylic alcohol is had, which, etherified anew by oxalic acid, furnishes oxalate of propyle almost pure. Hence we have a very simple mode of separation for two alcohols, which it would be almost impossible to separate by present processes.—On the stercoral anguillule, by M. Bavaz. This is the nematoid found in the stools of patients subject to diarrhœa of Cochin China. It is closely related to the *Rhabditis terricola*, Dujardin. It has been met with in the stomach, pancreatic duct, choledochus, hepatic ducts, and the walls of the gall-bladder, and in at least thirty patients.—On the flow of blood by tubes of small calibre (transpirability of Graham), by M. Haro. Heat accelerates the flow of defibrinated blood, and more so the richer the blood is in corpuscles; on serum heat acts much as on distilled water. Defibrinated blood which has had a current of CO_2 passed through it some time, and has then been filtered through fine linen, flows more slowly than the same blood made rutilant by decantation in free air. Sulphuric ether, containing no trace of alcohol, retards the flow of defibrinated blood, serum, and water. Chloroform retards the flow of water and serum, while it favours that of defibrinated blood. These facts have important physiological bearings.—Geological study of the prehistoric grottoes of Gréaulx, in their relation to thermal waters, by M. Saubert. The latter are shown to be the cause of the former.—New observations on the Phylloxera of the oak, compared with that of the vine, by M. Balbiani. The new facts prove a great resemblance between the two in their habits and the phenomena of their reproduction.—Results obtained in treatment of phylloxerised vines with sulphide of carbon; measure in which this treatment should be applied, by M. Allies.—On the orders and classes of certain geometrical positions, by M. Halphen.—Determination of nitric acid in organic substances; chemical composition of certain gun-cottons, by MM. Champion and Pellet. Organic substances containing nitrogen are completely reduced, in certain conditions, by ferrous salts, and behave like nitrates. Hence to determine the nitrogen, the authors adopt a modification of the process of Pelouze or Schlœsing. The composition assigned to gun-cotton corresponds to the pentanitrocellulose of Pelouze $C_{24}H_{15}O_{15}5NO_5$, not trinitrocellulose (Abel).—On the limits between which fire-damp explodes, and on new properties of palladium, by M. Coquillion. The first limit, with *excess of fire damp*, is 1 of fire-damp to 6 of air; the second, with *excess of air*, 1 of fire-damp to 16 of air. Palladium may with impunity be raised to a red heat in one of the most detonant mixtures known.—Note on the crystalline form of melinophane, by M. Bertrand.—The formula of seiches, by M. Forel.

GENEVA

Society of Physics and Natural History, September 7.—M. Raoul Pictet described observations by him made on an intermittent fountain in the neighbourhood of Vichy, department of Allier. The case under consideration does not belong to the class which may be accounted for by the ordinary explanation of a siphon charging and discharging itself subterraneously. The fountain is here projected at intervals from an artificial vertical hole pierced in the ground to the depth of more than 100 metres. Other borings made in the locality tend to prove that there exists at that depth an underground collection of water, under pressure, which permanently maintains the level of the water in the tube at three or four feet below the level of the ground. At intervals occurring four or five times during the day, bubbles of gas begin to rise in the liquid; then, in the space of two seconds, the water rushes out in force, and for a certain time to a height of twelve metres. No siphon hypothesis can be applied to the locality; the phenomenon must be explained by a mechanical action of another kind. M. Pictet supposes the pressure of the subterranean gas to accumulate above the surface of the water underneath. In certain places the surface of the earth above may present hollows the upper part of which is at a higher level than the lower orifice of the tube. The pressure increasing, gas may then enter the tube, diminishing the pressure of the liquid, which causes equilibrium with the subterranean pressure, and effecting an emission of water which will last until that equilibrium is restored. M. Pictet has devised an apparatus to prove his theory and which completely illustrates it. (Vide *Archives des Sciences Physiques et Naturelles*, September, 1876.)

CONTENTS

THURSDAY, OCTOBER 26, 1876

WEATHER CHARTS AND STORM WARNINGS

Weather Charts and Storm Warnings. By Robert H. Scott, M.A., F.R.S., Director of the Meteorological Office. With numerous Illustrations. (London: Henry S. King and Co., 1876.)

"DO you understand these *Isobars* on the weather charts?" we asked an amateur meteorologist who was showing us the curves which represented his own barometrical observations. "Well, I cannot say I do," he replied; "they are very interesting and curious, twisting one day one way, next day another way, and the third day turning all round." It is this not uncommon ignorance which the Director of the Meteorological Office seeks to dispel. His object is "to explain to the reader what he can learn from a careful study of the information published in the newspapers or in the daily weather reports," and for this end he has "attempted to give to the public an account of the actual state of our knowledge at present." He then exposes to public gaze all the mysteries of the Weather Office; he draws aside the curtain, and shows us

> *His* "copper-plate, with almanacks
> Engraved upon 't, and other knacks;
> *His* moondial, with Napier's bones,
> And other constellation stones."

The following are among the most important of these talismans:—The cyclonic law of the northern hemisphere—that if we turn our backs to the wind the higher barometer will be on our right hand, the lower barometer on the left; that the force of the wind is connected with the closeness of the isobars to a considerable extent; that we never have a storm unless the difference of pressure at two stations in the British Isles is less than half an inch of mercury. That cyclones proceed, in general, eastwards, their approach being frequently heralded by a tendency of the isobars to form closed curves; and that this is first seen in most instances towards the west coast of Ireland. These conclusions differ little from those which Dr. Lloyd deduced in 1854 from his study of atmospheric variations in Ireland. Anti-cyclones which have their greatest pressure at the centre are most frequently connected with light winds and fine weather.

All the deductions are illustrated by charts and curves from self-registering instruments, which enhance the value of this useful little volume.

Nothing, however, is more interesting than to see how the theories of meteorological writers for the last half century stand the test when confronted with the daily observation and practical application of facts. We cannot open a work on meteorology without finding all the great phenomena of varying atmospheric pressure ascribed to the action of the sun's heat in producing vapour and expanding the atmospheric gases. Thus the barometer is said to fall in a country because it is warmer there than in neighbouring countries, the more expanded air overflowing (thus causing a wind in the upper regions) towards the colder country, where the barometer rises; on the other hand, a surface wind is generated from the colder to the hotter region. But the most important of all movements admitted by every one were the polar and equatorial currents. The chief of the Meteorological Office treats the views of the great authorities to whom we have referred, in the following manner:—

"For many years it has been the fashion to say that all cold winds flowed from the poles to the equator, forming the so-called polar currents, and becoming the trade winds when they approached the tropics, while the warm winds flowed from the equator to the pole, forming the equatorial currents or anti-trades" (p. 20).

It is very like heresy to speak of "the fashion" and the "so-called polar currents," when their existence has been an article of faith accepted everywhere. It is true no one could say he had observed these currents; and we, who have sought for them in our own latitudes and within the tropics, have insisted that they were neither to be seen nor felt where their effects were supposed to be the greatest. No doubt one of our greatest writers on this subject put the equatorial atmosphere into one cylinder, surrounded by warm water, and the polar atmosphere into another, with an ice-cold jacket, and showed that if the stopcocks preventing communication at the top and bottom of the two cylinders, that is, the upper and lower passages from the equator to the pole, were opened, the currents referred to could be made visible. This, we think, is an illustration of what Mr. Scott, immediately after the passage quoted above, refers to as "right in principle." The atmosphere has also been supposed to have an upper surface like a lake, down which the expanded gases slide. Every condition in nature—density, distance, temperature, viscosity (besides those unknown to us) have been under-estimated, exaggerated, or neglected.

The author's conclusions, from his long watch of atmospheric variations, are somewhat different. He says:—

"The motions of the atmosphere are found to be mainly regulated by the distribution of barometrical pressure over the globe, the particles moving from the regions where the pressure is high to those where it is low," &c. (p. 21).

"Wind is always connected with some disturbance of the pressure of the atmosphere, and it will be at once understood that its existence is due to the tendency of an elastic fluid like air to regain the condition of equilibrium from whence it has by any means been disturbed," &c. (p. 27).

These conclusions are just the reverse of those usually entertained, especially with reference to tropical cyclones where the diminution of central pressure is attributed to the winds, and the movement in which is illustrated by a whirlpool caused by the difference of velocities, or opposite directions of motion of contiguous currents of water. In the cyclones of these latitudes we must suppose Mr. Scott to give, as the result of his experience, that the winds *follow* and do not *precede* the diminished central pressure.

In whatever way the subject is considered there will always remain many facts to some of which the author alludes, which cannot easily be explained by the action of cyclonic winds as causes of diminished pressure; and in these cases the question arises, what is the cause of the latter? This is no mere idle question, it is connected with the whole subject of weather prediction.

Thus, we may ask, with a fluid so mobile as the air, why are there atmospheric basins at the centre of which during months the mean pressure is half an inch of mercury below that in neighbouring regions? Why, in all the disquisitions on fluid equilibrium, are the constant low pressures in the antarctic regions south of 60° neglected? How shall we account for the permanent barometric depression in the neighbourhood of Iceland referred to by the author (p. 74)? And to come to our own country, how will cyclonic winds explain the fact that the pressure of the atmosphere diminishes on the average of the whole year at the rate of one-tenth of an inch of mercury for 4° of latitude as we proceed northwards, and increases at the same rate as we move southwards?

There are evidently atmospheric conditions with which we are unacquainted and for which no parallel can be found by experiments with air shut up in a box, in which it has been "the fashion" of some meteorologists to travesty our atmosphere. The variations of temperature and vapour tension which have been employed to explain everything occupy a very subsidiary place in weather predictions. Yet the effects of varying temperature on our atmosphere are to a great extent unknown to us; the only action taken into consideration has been that connected with expansion; but even expansion may affect properties of the atmosphere which have not as yet been investigated. Thus we know that the magnet which is expanded by heat loses magnetism, but of the way in which heat may affect the magnetism, the electricity, and the viscosity of the atmosphere we know nothing, and we are equally ignorant to what extent the pressure of the atmosphere may be affected by its varying electric state through humidity or otherwise. The satisfaction with which insufficient hypotheses have been received has retarded the progress of research for other causes; and it is a good sign of future advancement that a practical meteorologist like the author has left boldly the beaten track and given indications that we must try elsewhere.

Returning to the practical view, Mr. Scott says:—

"Various theories have been propounded to account for storms . . . but none of them have met with general acceptance as yet. We must, therefore, only take things as we find them, and endeavour to make the best of them" (p. 28).

This, in all senses, philosophic view of the subject, is also that of necessity—to make the best of what we know. To do this the author points out the importance of having more stations and more telegrams. As the great mass of storms approach us from the west, more stations are required, especially on the west coast of Ireland; stations also are required in the interior for the purpose of ascertaining the rate of progress of any threatening signal. This demand, there can be no doubt, will be granted, together with the means to procure any telegrams which particular cases may seem to require.

When we remember the great advantage of these storm warnings, not only to ourselves, but, as Mr. Scott has shown, especially to the ports on the western littoral of Europe (where our sailors and ships are also to be found), we trust every means will be given to make them more certain.

Though the Director of the Meteorological Office is forced to employ the knowledge he now has, he does not seem to feel less the necessity of obtaining more. In spite of the large proportion of successful warnings, he says, in the conclusion of his work, that weather telegraphy is "a branch of investigation which can hardly be said to have got out of the leading strings of infancy as yet" (p. 146). Although the infant stumbles little, all things considered, yet some astonishment has been expressed that it has not grown more rapidly.[1] This astonishment, we believe, has been due in part to an underestimate of the labour and difficulties connected with meteorological research. Every one considers he can commence as master in this subject, if he has only the observations or the instruments to make them with. This error is not confined to those ignorant of all science; it is partaken by many men eminent in other departments, who would smile if their own subjects were treated in a similar way by any tyro, whatever his knowledge otherwise. The low view thus taken of the qualifications necessary for successful inquiry in this branch of science has certainly not been supported by the results of importance which should have been so easily obtained, although meteorologists have counted in their ranks some of the most eminent mathematical physicists.

One of the great causes of the slow growth of meteorology is to be found in the long, laborious, and, not unfrequently, unfruitful calculations necessary in seeking laws from great masses of observations. The results obtained, if the inquiry has been successful, may be expressed in a few figures, which may not appear to have the slightest practical value. Few men qualified to direct the lines, and to devise the methods, of investigation have the time to devote to such ungrateful, and to a great extent mechanical, work. Hence the readiness with which speculative views, chamber theories, have been proposed instead, and these, when supported by men of talent, have made research to appear unnecessary or have thrown it into false channels.

Meteorology, it appears to us, will be best advanced by neglecting at present all theories, unless as far as they indicate new objects of investigation; and by the devotion of qualified workers, each searching in his own way. Also it should not be forgotten that it may not be possible to tell, *à priori*, in what direction the laws are to be sought, on which satisfactory weather predictions may be founded. It may be in some connection between the variations of the earth's magnetism and those of our atmosphere that warnings which will outrun the telegraph may be found; or it may be in some apparently insignificant fact discovered in a neglected corner. All the knowledge we now possess in meteorology would be practically valueless for storm warnings but for the useless-looking experiment of Oersted with a magnetic needle and an electrical current.

We should notice a few cases in which, it appears to us, some slight changes may be made with advantage in a second edition of the work before us. In his desire to be brief, the author has not been quite exact in his remarks on the dry and wet thermometers; thus, p. 5:—

"Suffice it to say, the greater the difference between the readings of the two thermometers, the drier the air,

[1] Mr. Scott gives a table showing that in 1873 and 1874 warnings were justified by subsequent gales 45·3 times in a hundred, and by subsequent strong winds 33·4 times per cent., or in all nearly four times in five (p. 139).

and when the two thermometers read alike, the atmosphere is exceedingly damp."

This statement is not likely to give any very definite idea of the conclusions which may be drawn from the readings of the thermometers, and the difference may be less at one time than another, and yet the air be "drier."

In cyclonic systems, the author says, "the air circulates more rapidly [than in anti-cyclonic], causing strong winds, and appears to flow in towards the centre, so that it must naturally be supplied from below and ascend in the centre." Here the rapid circulation of the air is said to be the cause of the wind. It is also said elsewhere that it is calm in the centre. Is it meant as a result of observation that the air flows towards the centre? and is it a result of observation that the air (naturally or not) rises in the centre?

We have already alluded to the little use of the tension of vapour in "storm warnings." With reference to one case, we find: "The absence of rain is very noticeable during the early period of the gale; the reason for this absence can be seen from the fact of the great distance [on the curves given] between the wet and dry thermometers." The difference is about 3° with the dry thermometer near 50°, and the wind blew "pretty steadily from S.S.W. for twenty hours" (p. 68). If the fact that it did not rain was an unusual one under the circumstances, and if that depended on the difference of the thermometers, the question seems to us only changed to what was the reason of the difference?

We do not always read the curves as the author has done, nor always agree with his reasoning from them; and in some cases, as p. 72, where one cyclone has passed eastwards, north of a station, leaving a N.W. wind, and is followed by another also passing north, the author has not made it very clear why the wind should back to S.W., to S., and S.E., through the action of the S.E. wind of the second cyclone meeting the N.W. of the first.

These queries and suggestions do not affect the general character of the book, which we can recommend as a useful and instructive companion in the study of weather charts, and for the comprehension of storm-warnings as they are issued from the Meteorological Office. It is much to be desired for the many who will not read this work, yet cast a curious eye on the isobars in the newspapers, that some condensed statement of the general rules should occasionally accompany them.

JOHN ALLAN BROUN

GEIKIE'S GEOLOGICAL MAP OF SCOTLAND

Geological Map of Scotland. By Archibald Geikie, LL.D., F.R.S., Director of the Geological Survey of Scotland; Murchison Professor of Geology and Mineralogy in the University of Edinburgh. (Edinburgh and London: W. and A. K. Johnston, 1876.)

SINCE the publication of the last edition of the sketch-map by Sir R. I. Murchison and Prof. Geikie, no general geological map of Scotland has, so far as we are aware, been issued, while those older than the sketch-map rather served as guides to localities where minerals and rocks were to be found, than afforded any clue to the subdivisions of geological time represented by our ancient formations. During the last twelve years, however, materials have been accumulating which have daily rendered the sketch-map more and more inadequate to the purposes for which it was originally designed, and it had obviously become necessary either to issue a new edition, or to "reform it altogether." Considering all things, and especially that he could no longer avail himself of the co-operation of his late colleague, Prof. Geikie has, wisely we think, decided on the latter course. The comparatively large scale adopted (ten miles to the inch), gives room for a number of details which had to be omitted from previous maps.

The publication, for the greater part of the south of Scotland, of the Geological Survey Maps on the scale of one-inch and six-inches, reduces to some extent the operations of the compiler to the selection of as much of the details as his map gives him room to insert. At the same time there are many points regarding the relations of distant deposits which can be better seen on reviewing the work as a whole than during the progress of detailed mapping, and on some of these, as we shall presently point out, Prof. Geikie takes up an independent position.

The northern half of Scotland is in a very different state as regards our knowledge of its geology. Here and there, it is true, competent observers have selected choice bits, and have worked them out with a thoroughness that leaves little to be desired. But a great part of the Highlands is still unknown to geologists, or only known in so far as concerns its comparatively simple glacial phenomena. For this region we have to consult "geognostic travels" of the beginning of the century, and put the best construction on them that we can. It is not, therefore, to be wondered at that this portion of the map is somewhat vague. The metamorphic rocks of the Highlands offer difficult problems to the chemist and physicist, as well as to the geologist; and whoever attempts to unravel their structure as a whole, must probably be content to work for some years in the dark, and with the consciousness that he may not see the issue of his own labours.

Till recently the Southern Uplands were pretty much in the same state as the Highlands, but the detailed work of the geological survey, and a few private observers, has filled up this great blank and rendered possible a comparison of the structure of the Silurian rocks there with those of England and Ireland. On the map now before us, are laid down, for the first time, all the more important graptolite bands which for a hundred miles, at least, appear at intervals among the upturned Lower Silurian strata between the Rhinns of Galloway and the Tweed, while a marginal section explains how the Llandeilo beds, after folding over and over, are unconformably succeeded near the northern edge of the uplands by Caradoc basins, and on the south by rocks supposed to be Upper Silurian. It thus appears that on the Southern side of Murchison's "axial beds" only a small part of the northern series is repeated, the place of the Moffat shales not being reached at the point where the Upper Silurian rocks begin.

North of the Uplands a notable feature of the new map is the rearrangement of the Old Red and Carboniferous boundary-line. The identity of the bright-red, sharp, siliceous sandstones below the cement-stone series of the

Lower Carboniferous group with the sandstones answering to the same description that rest unconformably on the Lower Old Red of Forfarshire is regarded as established notwithstanding the occurrence in their associated limestones (in Nithsdale and elsewhere) of carboniferous limestone fossils. This bold course may be taken as a protest, on Prof. Geikie's part, that such questions are not to be settled on palæontological grounds alone.

Along the southern edge of the Grampians the present map shows that the fault which for a long distance separates the Silurian slates from the Old Red Sandstones and conglomerates, runs all the way from Strathearn to Glen Esk (a distance of about fifty miles), within the old red area. Here then we have a noble exposure of the base of that formation abutting against its Silurian shores; and we learn from its interbedded igneous rocks and trappean conglomerates, that even thus early, volcanic activity had set in on the margin of the Highlands. As far north as the Orkney Isles, the sub-divisions of the old red have been re-arranged, Prof. Geikie having himself observed the unconformability of the red sandstones (Upper Old Red) on the Caithness Flags on the west coast of Hoy.

In the Silurian Highlands many of the chief folds and variations of the metamorphic rocks are clearly indicated, and old mineralogical observations are corrected, largely through Prof. Geikie's own frequent traverses. The Laurentian and Cambrian rocks of the north-west coasts and islands seem to have suffered no changes since the publication of the sketch-map, except slight rectifications of boundaries required by the larger scale.

Much light has been thrown within the last few years on the mesozoic and tertiary rocks of the Moray Firth, Skye, Mull, and Arran, and this new information has been skilfully embodied in the map. Besides his own work in this department Prof. Geikie justly acknowledges his obligations to Ramsay, Judd, Bryce, and Zirkel.

It has been found possible to indicate at least two phases of the Glacial epoch, that of the main extension of the ice-sheet, and that of the later local glaciers. Of the direction of the ice-flow during the former phase an idea may be gathered from the arrows denoting observed glacial striæ, while the moraines of the later period are shown by a neat system of stippling. Both in the Highlands and the Southern Uplands the number of valleys containing glaciers seems to have been very great. Scotland must have been a magnificent country for tourists in these pre-historic times.

In conclusion, we need only say that geological students have now in their hands a portable map that will supply them with much valuable information, and with suggestions equally valuable with regard to problems awaiting solution. Prof. Geikie is to be congratulated on the successful completion of a task for which he was peculiarly qualified, both by his position as Director of the Survey and by his thorough acquaintance with the minutest details of Scottish geology. R. L. J.

OUR BOOK SHELF

Botanical Reminiscences in British Guiana. By Richard Schomburgk. (Adelaide: 1876.)

THE able and indefatigable superintendent of the Botanic Garden at Adelaide was appointed, many years since, by the Prussian Government, naturalist to the Boundary Expedition to British Guiana entrusted by the British Government to his late brother, Sir Robert Schomburgk; and in this small, but extremely interesting volume, he gives an account of that "El Dorado," as he appropriately terms it, of tropical botany. Dr. Schomburgk's description of the floral treasures of the district, and especially of the Roraima mountains, where forms of the most wonderful beauty unfold themselves at every step, and undergo the most rapid transformations with every change of altitude, are enough to make the mouths of stay-at-home botanists water. The expedition was not, however, without its difficulties and dangers. On the Roraima mountain, which rises to the height of about 8,000 feet a few degrees north of the equator, the humidity of the air was so great that the artist who accompanied the expedition found sketching on the saturated paper impossible, while the powder in a loaded gun became changed, in a few hours, into a greasy mass. The ascent of the upper part of this mountain chain was a feat worthy of the most enterprising members of the Alpine Club. A perpendicular wall of sandstone rock, 500 feet in height, had to be scaled by the entire party by means of the net-work of climbing plants which covered it; the giving way of a single root would have involved one or more of the party in certain death. The account of this expedition dissipates the idea that food is everywhere abundant within the tropics, even in thickly-wooded and well-watered countries. For days together the party saw no mammals or birds, and were reduced to the point of starvation from the absence of all esculent vegetables. One observation of Dr. Schomburgk's is important, as being at variance with our modern theories regarding the purpose of the bright coloration of flowers. Near the summit of the mountain range, where the earth was carpeted with flowers of gigantic size, of the greatest brilliancy of colour and delicacy of scent, "it appeared almost as if this boundless abundance of flowers compensated for the total absence of animal life; all was wrapt in deep solemnity; not even a gorgeous humming-bird or a graceful honey-sucker was seen fluttering amongst the flowers." Has this singular observation been confirmed by other American travellers? Dr. Schomburgk's observations were not entirely confined to the flora of the country. While stopping at a Warrau settlement on the Barima river, he records the curious fact of a young woman nursing at one breast a child and at the other a young monkey; and states furthermore, that he has seen, "with the exception of the carnivorous, all kinds of animals suckled and reared by Indian women." While ascending the Roraima mountains his attention was arrested by rows of Indian hieroglyphic writing on the sandstone rock, roughly representing, for the most part, the human form, kaimans, and snakes. There is one defect in this interesting volume, which should have been rectified before going to press. Either from want of exact knowledge of the language on the part of the author, or from the deficiencies of a colonial printing-office, many of the sentences are so inaccurately worded as to be barely intelligible. A. W. B.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

On the word "Force"

IN the *Times'* report (Sept. 9, 1876) of Prof. Tait's lecture at Glasgow on Force, it is stated that "the lecturer showed how the incorrect physical ideas of Leibnitz, and some of his followers, had introduced the terms *vis viva, vis mortua,* and *vis acceleratrix,*" and that these terms were found also in English works. We may add that, until quite lately, Cambridge treatises

on Mechanics always used the expressions "accelerating force" and "moving force" (to the great confusion of learners), with the noteworthy exception of Sandeman's "Motion of a Particle," where "effect" was used for "force." So troublesome and misleading was this terminology found for students that one well-known Cambridge writer in a little work on Dynamics, introduced it in a way which reminds one of the trembling and caution with which Sidney Smith brought the word "metaphysics" before his audience at the Royal Institution. But these authors could claim the venerable authority of Newton for those terms; and if they had taken care to introduce them in the *exact way in which he does*, no difficulty would have ensued. Unfortunately, until Mr. P. T. Main edited Newton's "Sections," our editions of that work began with Lemma I., and ignored his "Definitions" and "Laws of Motion." In the "Definitions" Sir I. Newton tells us that the term "accelerative force" is used as an abbreviation for "the accelerative quantity of a force," or the velocity generated by it in a given time; and the term "moving" or "motive force" as an abbreviation for "the motive quantity of a force," or the momentum generated by it in a given time; and if these expressions had always been explained in this way, *i.e.* as signifying what may be called the *velocity-effect* and the *momentum-effect* of a force, there would have been no room for misconception and no need of cautioning the learner against the notion that there were *two different kinds* of force. Perhaps with regard to Leibnitz it may be questioned whether his physical ideas were so incorrect, and whether he may not have used the terms referred to in the same way that Newton did, viz., as abbreviations, and so as to embody the notions of the different *effects* of a power or influence on the motion of a body, viz., its work-effect, its momentum-effect, its velocity-effect, &c. It must, however, be allowed that the term "conservation of *force*" (originally it seems due to Helmholtz) is very misleading, for a meaning of "force" is therein required which is not included in the original dynamical ideas; and the notion intended to be conveyed could only be given by a new term, "energy," or work-power, with its attributives actual and potential. But, after all, the whole controversy on the word "force" is as to the *method of measuring* a pressure or tension; if we regard the *time* of the action, the effect is represented by the momentum; and if the *space* through which exertion is made, the effect is represented by the work.[1] Either of these would then measure "force," and there would be no inaccuracy if careful explanation were given as to the method used and the sense of words. W. P. O.

Arnesby, Rugby

P.S.—In Prof. Tait's view of "force" is there not a confusion between *being* a mere rate and *being measured* by a rate?

[Our correspondent refers merely to the short abstract given by the *Times* of Prof. Tait's Lecture. Some of his remarks will be found inapplicable to the fuller report in our own pages. —Ed.]

[1] "Walton's Mechanical Problems," chap. x.

Mr. Wallace and his Reviewer

In Nature, vol. xiv. pp. 188, 189, in a review of Mr. Wallace's recent work on "The Geographical Distribution of Animals," occurs the following paragraph: "Mr. Wallace admits the validity of *Elasmognathus* of Gill as a genus of Tapirs, and adopts Dr. Gray's multitudinous division of the well-defined and eminently natural group of the Eared Seals (*Otaria*). Many naturalists would hesitate before following Mr. Gill or Dr. Gray as authorities on these (or perhaps we may add many other) subjects."

I freely admit the truth of the proposition that there are "many subjects" on which I am not authority, if I am on any; there are none, I presume, who are authority on all things. I will not even contest the allegation as to wrong-doings in regard to the generic differentiation of Baird's tapir; I beg, however, to be allowed to excuse myself by "authority" for such wrong-doing.

The animal in question is distinguished from all others (I have seen skins and skeletons of every known species, and about 100 skulls), and especially from the typical American tapirs by the want of basal apophyses to the nasal bones, the extension of the supramaxillaries behind, into their lowellæ, and their extension upwards into swollen portions, which tightly embrace the mesethmoid, the complete ossification of the latter in the adult; with these features are co-ordinated others less marked, *e.g.*, abbreviation of the cranial box, comparatively small size of the cerebral cavity, &c. The genus has been accepted by Prof. Verrill, Dr. von. Frantzius, Dr. Murie (see his article in *Journ. of Anat. and Phys.* vol. vi., pp. 131–169), as well as Dr. Gray, and every trained mammalogist and anatomist to whom I have shown the skulls (*e.g.* the late Prof. Agassiz, Prof. Baird, Prof. Cope, E. Coues, Dr. H. Allen, Mr. J. A. Allen) have concurred with me that the type is entitled to generic distinction.

As to the eared seals, the critic is wrong as to a matter of fact. Mr. Wallace has *not* followed Dr. Gray in his arrangement of the constituents of that family, but, as he expressly states, has followed Mr. J. A. Allen's elaborate monograph of the *Otariids* of Western America. Two more different arrangements of the same group could scarcely be. For the generic features of the arrangement adopted, I am quite willing to assume the responsibility which Mr. Allen has devolved upon me,[1] notwithstanding the critic's emphatic condemnation. Beside Dr. Gray and myself, F. Cuvier and many of the other older naturalists, as well as Allen, Scammony Elliott, &c., have recognised generic differences between the Otariids.

But over and above all these I can plead in extenuation of my wrong-doing the example of a very eminent and accomplished naturalist, Mr. P. L. Sclater; I feel assured that I am not mistaken in supposing he will be regarded as the best possible authority on such subjects. That zoologist has differentiated the deer into genera distinguished *solely* by the palmation or non-palmation of the horns and many genera of birds on equally slight ground which your limits forbid me to mention. I think no rational naturalist familiar with the details of structure of the deer and tapirs and the variations of horns in the former, will contend that the differences between the tapirs is of less systematic importance than those used to differentiate *Cervus* and *Dama*. Hence I think I have the best precedents for my action, and if I am subject to censure, the eminent Englishman whom I have cited is still more so.

But far be it from me to deny that my critic is not at all correct in his statement (shortly preceding the passage first quoted) that "it would be easy to point out many passages in which Mr. Wallace has not, in our opinion, made the most judicious choice of authorities." One passage (*Op. cit.*, vol. ii. p. 120) I beg to reproduce in corroboration, but, in justice to Mr. Wallace, I must add that although there are many other errors, the passage thus quoted is an exceptional one in a valuable work.

"*Fresh-water Fishes.*[2]—The Nearctic region possesses no less than (1) five peculiar family types, and (2) twenty-four peculiar genera of this class. The families are *Aphredoderidæ*, consisting of a single species found in the (3) Eastern States; *Percopsidæ*, founded on a species (4) peculiar to Lake Superior; *Heteropygii*, containing (5) two genera peculiar to the Eastern States; *Hyodontidæ* and *Amiidæ*, each consisting of a single species. The genera are as follows: (6) *Paralabrax*, found in California; (7) *Huro*, peculiar to Lake Huron; (8) *Pilcoma*, *Bolcosoma*, (9) *Bryttus* and (10) *Pomotis* in the Eastern States—all belonging to the Perch family. (11) *Hypodilus* and *Noturus*, belonging to the *Siluridæ*. (12) *Thaleichthys*, one of the *Salmonidæ* peculiar to the Columbia River. (13) *Moxostoma*, (14) *Pimephales*, (15) *Hyborhynchus*, (16) *Rhinichthys*, in the Eastern States; (17) *Ericymba*, (18) *Exoglossum*, (19) *Leucosomus*, and (20) *Carpiodes*, more widely distributed; *Cochlognathus*, in Texas; (21) *Mylaphorodon* and *Orthodon*, in California; *Meda*, in the River Gila; and *Acrochilus*, in the Columbia River—all belonging to the *Cyprinidæ*. *Scaphirhynchus*, found only in the Mississippi and its tributaries, belongs to the sturgeon family (*Accipenseridæ*)."

Whatever may be the "authority" followed, the following are the facts almost all familiar to every American ichthyologist, and matters of record respecting the forms enumerated. (1) *Five* families are mentioned in one place (just quoted), and *six* in others (*op. cit.*, vol. ii., pp. 115, 143); but the sixth (*Lepidosteridæ*) is not peculiar; (2) Twenty-four genera are said to be peculiar, but twenty-*nine* are enumerated, as is indeed recognised in the next paragraph of the work. (3) The family *Aphredoderidæ* is represented by two species found in the Western and Southern as well as Eastern States; (4) The *Percopsidæ*, far from being confined to Lake Superior, are found at least as far as Lake Champlain to the east, the

[1] "These [genera recognised by Gill] appear to be natural groups of true generic rank, and properly restricted; and, after a careful examination of the subject, and specimens of four of these five types, they appear to me to include all the natural genera of the family."—Allen, "On the Eared Seals (*Otariidæ*)," p. 38.

[2] The punctuation of the original is reproduced.

Potomac River to the south, the Ohio River in the west, and many other places; (5) The *Heteropygii* have three genera (as understood by Putnam, the only naturalist who has thoroughly studied them) confined to the western and southern states; (6) The genus *Paralabrax* is an entirely marine one, very closely related to *Serranus* (*cabrilla*, *scriba*, &c.), and is represented extensively on the western coast of America, as well as elsewhere in the Pacific Ocean; (7) *Huro nigricans* (the only species) is a mere synonym of *Grystes* or *Micropterus nigricans*, which extends to Florida in the south-east, and Mexico toward the south-west; (8) *Pileoma* is a later name for *Percina*; (9) *Brytus* and (10) *Pomotis* are not *Percidæ* according to most American authors, nor according to Dr. Gunther's recently promulgated views (the vertebræ being only *A* 10 + *C* 14), and belong to a quite peculiar family; (11) *Hypodelus* is a misnomer for *Hopladelus*; (12) *Thaleichthys* is as much a marine genus as *Osmerus* (Smelts); there is no such restriction at all as indicated by the remarks on the distribution of (13) *Moxostoma*, (14) *Pimephales*, (15) *Hyborhynchus*, and (16) *Rhinichthys* on the one hand, and (17) *Ericymba*, (18) *Exoglossum*, (19) *Leucosomus*, (= *Semotilus*), and (20) *Carpiodes* on the other; and the categories might indeed, as to most causes, be almost reversed; (21) *Mylaphorodon* is a misnomer for *Mylopharodon*. The number of genera enumerated as peculiar might, too, be very safely more than doubled, and by reference to Günther's work and subsequent corrections, *Centrarchus*, *Ptyonotus* (= *Triglopsis*), and *Hysterocarpus* could have been added. All these errors might have been prevented if Mr. Wallace had been familiar with ichthyology and its literature. The paragraph cited also quite conceals the remarkable distribution into secondary faunas of the American genera, and is calculated to entirely mislead respecting the contrasts between North America and the Old World. His use of the term "Eastern States" (instead of "Eastern Province," as Baird calls the division meant) is confusing, inasmuch as it is a geographical designation for a particular group of states.

Smithsonian Institution, Washington, September 21 THEO. GILL

The Self-Fertilisation of Plants

UNDER this title there is an article in NATURE, vol. xiv. p. 475, mentioning some observations on flowers, and concluding thus:—"In view of these examples . . . . it can hardly be that colour, fragrance and honeyed secretions in flowers have been developed solely to secure cross-fertilisation." In reply to this article it may be worth showing that of the examples relied upon the first and last are most probably incorrectly observed and erroneously interpreted, whilst the others are of no consequence at all, so far as the good effects of cross-fertilisation are concerned.

First, the flowers of *Browallia elata* have been most accurately described by F. Delpino ("Ulteriori osservazioni sulla dicogamia nel regno vegetale," Parte I. p. 140-143), and this excellent observer has fully convinced himself that it is cross-fertilised whenever it is visited by Lepidoptera or Bombylius.

Claytonia virginica and *Ranunculus bulbosus* simply confirm the well-known fact that many flowers have recourse to self-fertilisation when not visited by insects (see H. Müller's "Befruchtung," p. 443-448, NATURE, vol. viii. p. 433, vol. ix. pp. 44, 64, vol. x, p. 122).

As to the last example, *Ranunculus abortivus*, it is inadmissible to conclude from the fact that one has not observed visitors on a plant, that this plant is wholly neglected by insects.

With regard to the article as a whole, it seems to me somewhat rash to call in question a comprehensive and well-founded theory on the basis of a few superficial observations.

Lippstad, October 20 HERMANN MÜLLER

The Proposed Zoological Stations at Kiel and Heligoland

IN NATURE, vol. xiv. p. 535, there appears amongst the occasional Notes, a short report of a proposal of the Association of German Naturalists to found two new Zoological Stations at Kiel and Heligoland. The establishment of such stations could not fail to be of immense service to biology, but it is much to be regretted that the Association is inclined to put aside the claims of the present Zoological Station at Naples in favour of these two new institutions. To act in this way would be both unwise and ungenerous: unwise, because a station on the shores of the Mediterranean can obtain a great variety of forms which are not to be found in the North Sea and the Baltic; and ungenerous because the Naples Station has been the means of proving both the value and feasibility of such institutions, and without it the present proposals would never have originated. It is indeed surprising to see a body of German naturalists refusing their support to an institution like that at Naples, which has already rendered such signal services to biology, in which so many of themselves have made important discoveries, and which is, moreover, founded almost on the site of the classical investigations of Kolliker, Gegenbaur, and Hæckel.

It is to be hoped that the Commission appointed by the Association to draw up a memorandum will see their way to urging the claims of the existing Zoological Station at Naples without thereby interfering with the prospects of the similar institutions which it is proposed to found. F. M. BALFOUR

Trinity College, Cambridge

The Flame of Chloride of Sodium in a Common Coal Fire

MR. HARDMAN, in NATURE, vol. xiv. p. 506, gives an account of a number of experiments which he considers to bear out the old theory that the blue flame produced by throwing common salt on a coal fire is due to carbonic oxide. His letter induces me to give an account of a series of experiments which I made last winter, in company with Mr. R. A. Lundie, and which led me to an exactly opposite conclusion. Our experiments were all made with the help of a spectroscope, no dependence being put on observations made with the naked eye:—

1. We examined, with the spectroscope (which was a small direct-vision one), a *very distinct* blue flame of CO, burning in a coal fire; this, as far as we could see, gave no bright lines. A little common salt was then put on the fire, when at once a very marked spectrum appeared, the most characteristic part of which was a pair of bright lines in the blue, and another pair in the violet beyond the spectrum of the glowing coals, against which the flame was generally seen. This flame was very persistent, and frequently long after the *flame* had ceased to be distinguishable, the *spectrum* was still quite marked.

2. We did not succeed in getting the spectrum with other salts of soda, such as carbonate, phosphate, and borate; nor yet with microcosmic salt, while on the other hand, with other chlorides and chlorates, such as KCl, $KClO_3$, and NH_4Cl almost exactly the same spectrum was obtained, and with bromide of potassium a very similar, if not an identical, spectrum was also obtained.

3. We were able, but with more difficulty, to get the characteristic spectrum, when a blow-pipe flame was made to play down on chloride of soda, or ammonia, lying on an iron plate; and in this case it was observed that the blue flame *seemed* to be produced only when the flame which had passed over the salt came to a colder part of the plate where there was more salt.

Want of time has prevented me from continuing my experiments, and I do not venture to suggest any theory to account for the phenomenon. It is possible that part of the blue blaze is due to carbonic oxide, but I am convinced that this is not a complete explanation. Neither do I think that Mr. Muller's explanation (NATURE, vol. xiii. p. 448) is sufficient, though a number of our earliest experiments, in which a brass plate took the place of the iron plate (in experiment 3), certainly favour this explanation to a certain extent. The flame thus produced gave the characteristic spectrum very brightly, but at the same time new lines (copper) appeared in the green. I would add that I have as yet been unable to get satisfactory measurements of the positions of the lines, the spectroscope I used for most of my observations having no micrometer nor scale.

C. MICHIE SMITH

Keig, Aberdeenshire, October 13

OUR ASTRONOMICAL COLUMN

THE INTRA-MERCURIAL PLANET QUESTION.—M. Leverrier has made a further communication to the Paris Academy on this subject. With the view to testing the sufficiency of the method employed, to afford a guide for prediction of future transits of such a body over the sun's disk, admitting that the observations in which appreciable motion is recorded really refer to an intra-Mercurial planet, he applies it in the case of Mercury. Tran-

sits of Mercury were observed by La Concha at Monte Video, November 5, 1789; by Keiser at Amsterdam, November 9, 1802; by Fisher at Lisbon, May 5, 1832; and by Houzeau at Brussels, May 8, 1845. Taking for the heliocentric longitudes of the body observed, the tabular longitudes of the earth at the epochs of the observations, the following formula for the heliocentric longitude (ν) at any time, is obtained—

$$\nu = 56^{\circ}{\cdot}04 + 4^{\circ}{\cdot}092307 j - 7^{\circ}{\cdot}66 \sin \nu - 9^{\circ}{\cdot}18 \cos \nu,$$

where j is the number of days from November 5, 1789.

Then admitting the place of the node of the orbit to be in 40°, a transit is indicated by the formula for November 9, 1848, which actually took place.

The problem under discussion, as it refers to a possible intra-Mercurial planet, is susceptible of many solutions, which it becomes necessary to determine. They are comprised in the formula

$$\nu = 139^{\circ}{\cdot}94 + 214^{\circ}{\cdot}18\,k + (10^{\circ}{\cdot}901252 - 1^{\circ}{\cdot}972472\,k) j + (-5^{\circ}{\cdot}3 + 5^{\circ}{\cdot}5\,k) \cos \nu.$$

j in this case being reckoned in days from 1750·0, and k being an indeterminate, which may receive values either positive or negative, but necessarily whole numbers.

If $k = 0$, the solution, very precise, is the one already given where the duration of a revolution is 33·02 days, and the semi-axis 0·201.

If $k = -1$, the solution is as exact as the preceding one. The revolution is 27·96 days, and the semi-axis major 0·180.

If $k = -2$, the solution is less exact; the revolution becomes 24·25 days less than the period of the sun's rotation.

If $k = 1$, a solution of the same degree of precision with the last is obtained, with a revolution of 40·32 days.

And if we put $k = 2$, when the revolution would be 51·75 days, large errors will remain.

In all these hypotheses the calculated epochs of transit in 1859 (Lescarbault) and 1862 (Lummis) are very nearly the same. Under these conditions M. Leverrier assumes that we may venture on the calculation of the times of future conjunctions, which occur in the vicinity of the nodes, situated in 192°·9 and 12°·9, the first point being the ascending node, and with the orbit corresponding to $k = 0$, he determines the times of conjunction in the intervals 1853–1863, 1869–1877, and 1885–1892. The tables show that the epochs of transits will be regulated by a period of about seventeen years, in the middle of which the transits will occur, but after which none would be seen for many years. Lescarbault and Lummis it appears observed at the end of one series of transits, which explains why in searching after them in the same region of the sky observers have not seen anything, and seven or eight years might elapse without more success. M. Leverrier then examines the possibility of a transit of the hypothetical planet in the spring of 1877. The conjunction with the sun would occur on March 22 at a distance of 10°·9 from the node, and if this distance be considered certain, as well as the assumed inclination of 12°, there would not be a transit, but in view of very probable modifications of these numbers, a transit may be possible; and he then urges observers to a close watch upon the sun's disk on the 22nd of March next, seeing that there would be no other transit at the spring node before 1885; and a similar examination of the conjunctions at the opposite node (September and October) shows that for the present they do not occur under more favourable conditions. The conjunction in 1876 would take place on September 21, when a transit, though not altogether impossible, is very doubtful. For a transit at this node it is necessary, under the assumed conditions as to the position of the orbit, to wait until about 1881.

For the present, then, there remains no other resource than a direct search off the sun's disk, and M. Leverrier remarks that Dr. Janssen "ne désespère pas d'y parvenir, grâce aux perfectionnements de l'optique céleste, auxquels il a si puissamment contribué." The remaining part of the communication to the Academy is occupied with ephemerides of differences of right ascension and declination of planet and sun for the last half of October.

Mr. De la Rue has instituted a very close examination of the Kew heliographs, with some interesting results.

THE VARIABLE STARS S CANCRI AND U GEMINORUM.—The following are times of visible geocentric minima of S Cancri, calculated from the elements of Prof. Schönfeld's latest catalogue, where the period is 9d. 11h. 37·75m.:—

	d.	h.	m.		d.	h.	m.
1876, Oct.	30	15	9	1877, Jan.	14	12	3
Nov.	18	14	22	Feb.	2	11	18
Dec.	7	13	35	,,	21	10	35
,,	26	12	48	March	12	9	52
				,,	31	9	9

While the irregularity of intervals between the observed maxima of U Geminorum of late years appears to forbid the hope of making a reliable prediction of these epochs at present, it may assist observation of the right object if it is noted that the variable precedes the principal component of Σ 1158, 1m. 26·5s., and is north of it 7′ 31″. The writer is informed by M. Otto Struve that this star does not quite disappear in the Pulkowa refractor, but with instruments of more ordinary dimensions it is invisible during the greater part of the period of 9½ days. There is a star 12·13m. very near its position.

BIOLOGICAL NOTES

CEPHALISATION.—Such is the name given by Prof. Dana to what he terms a fundamental principle in the development of the system of animal life. Its meaning can be best explained by the employment of the instances used by its author. The lobster and the crab are closely allied decapod crustaceans. In the lobster the tail is large, the cephalo-thorax elongate, and the antennæ of considerable size. In the crab the tail is minute, packed under the cephalo-thorax, which is short, as are the antennæ; and from this we may infer that passing upwards from the Macrural to the Brachyural forms there is an abbreviation and a compacting of structure before and behind the head. "In the whale the tail is the propelling organ and is of enormous power and magnitude, and the brain is very small and is situated far from the head extremity in a great mass of flesh and bone furnished with poor organs of sense." The principle is therefore that in low types "there is, usually, large size and strength behind, an elongation of the whole structure, and a low degree of compactness in the parts before and behind; in the high, there is a relatively shorter and more compacted structure, a more forward distribution of the muscular forces or arrangements, and a better head." The analogy is ingenious, but we can see nothing of value in the argument more than a repetition of the well-known principle that height in the scale of creation and amount of cerebral development are correlated phenomena. Are we to place the koala, which, by the way, is wonderfully like some of the much higher Lemurs in its proportions, at the top of the Marsupial phyllum and the kangaroos at the bottom, because the former wants the tail and has a blunt nose, whilst the latter have an enormous caudal appendage and a slender snout? Is the sun-fish so much higher than the eel, and the ostrich than the lyre bird? We fear that cephalisation is not a true law of nature.

RHINOCEROSES.—Anyone visiting the Zoological Gardens in Regent's Park at the present time can obtain ocular proof of the existence of two species of single-horned rhinoceros, differing in size, texture of integument, and skin-folding. On a former occasion (NATURE, vol. ix. p. 466) we were able to demonstrate to our readers the distinguishing points in the last-mentioned of these features, and in the

present instance we desire to draw their attention to an important paper by Prof. Flower, F.R.S. (*Proc. Zoolog. Soc.* 1876, p. 443), just published, on the differences between the skulls of the same two species. There are thirty skulls of single-horned rhinoceroses in the two great metropolitan zoological museums, and from a comparison of these Mr. Flower has been able to draw several important conclusions. One of these is that in the Indian Rhinoceros (*R. unicornis*) the posterior termination of the bony nostrils (the mesopterygoid fossa) is considerably narrower than in the Javan species (*R. sondaicus*), at the same time that the vomer terminates behind by becoming lost, through fusion, in the pterygoid processes, instead of ending free, lamelliform, and pointed. In the Indian rhinoceros, also, the upper grinding teeth have a pattern which is easily distinguishable from that of the Javan animal, a peculiar little circular "accessory valley" being developed in the first and second molars of the former, not found in the latter. In the same paper Mr. Flower also brings forward an interesting difference between the skulls of the single and double-horned rhinoceroses, the external auditory meatus being embraced below by the fusion of the post-glenoid and post-temporal processes of the squamosal portion of the temporal bone in the one group, whilst in the other these two processes remain separate, as in the horse and tapir. The African species agree with the two-horned Asiatic in this respect, so that the character separates the unicorn from the bicorn Rhinoceroses.

PASSERINE BIRDS.—Within a few pages of the paper above referred to is one by Mr. A. H. Garrod upon some of the peculiarities in the anatomy of Passerine Birds. The nature of the voice-organ is the point laid most stress upon. For a long time it has been known that there is a small section of the Passerine birds which has no muscular organ of voice that may be employed for singing. These *all* were supposed to inhabit America, although from the conformation of their wings, wherein they alone resemble the aberrant genera just mentioned, Herr Cabanis, of Berlin, as long ago as 1846, predicted that the Old World Ant Thrushes (*Pittidæ*), lacked the voice organ. Mr. Garrod, from a dissection of several specimens of two species of *Pitta*, demonstrates that Cabanis was quite correct in his surmise, and that the voice-organ is absent in them. He also describes the same organ in the Lyre Bird of Australia (*Menura superba*), and in its diminutive and interesting ally *Atrichia rufescens*. The paper ends with an outline plan of the classification which introduces more than one novel feature.

BAROMETRIC VARIATIONS

IN the "Notes," NATURE, vol. xiv. p. 464, I see reference is made to my results on this subject, and it is suggested that General Myer's International observations will be of the greatest value in connection with the question whether there may not be some other attractive force than gravitation connected with these variations.

I had come to the conclusion nearly twenty years ago (see British Association Transactions for 1859) that the *mean* pressure of the atmosphere for the whole globe was probably less for July than for January. This conclusion was derived from observations made at a great number of stations in both hemispheres during these months in the same year (1844). A considerable part of the earth's surface was not covered by these stations. About a year ago I received from Gen. Myer a copy of the *Bulletin of International Observations* made on February 7, 1875, at 7h. 35m. A.M., Washington Mean Time, and I was glad to see in such observations the means of making more complete comparisons of the mean barometric pressure for given instants on different days. It was only a few months later that I found I could obtain a sight of other *Bulletins* at the Meteorological Office. I had time, however, to compare only two *Bulletins*, that sent me by Gen. Myer for February 7, and another for the 27th of the same month (1875) which seemed to show a lower pressure generally than the first. Other investigations have prevented me from seeking for a larger series of *Bulletins* to carry out the comparisons; but it seems to me that the comparison then made is sufficiently interesting to merit notice.

The mean barometric pressure at 7h. 35m. A.M., Washington M.T., was found for each of the countries in the *Bulletin*, on each of the two days mentioned; the differences of these mean pressures were then taken; they are given, with the numbers of stations from which the results are obtained, in the following table:—

Country.	Number of Stations.	Difference of Pressures. in.
Russian Empire	23	+ 0·19
Denmark	3	+ 0·21
Greenland, Iceland, and Faroe	3	− 0·48
Norway	3	+ 0·33
Austria	12	+ 0·06
Turkey	5	+ 0·19
Mediterranean, Gibraltar, Corsica	3	+ 0·15
Germany	21	+ 0·30
Switzerland	2	+ 0·68
Italy	13	+ 0·32
Algeria	9	+ 0·27
Netherlands	4	+ 0·52
Belgium	1	+ 0·55
France	21	+ 0·54
Spain	1	+ 0·27
Portugal	1	+ 0·26
Great Britain and Ireland	41	+ 0·32
Canada	18	+ 0·53
United States	96	+ 0·37
West Indies	7	+ 0·09
Ceylon	1	+ 0·21
Cape of Good Hope and Natal	2	0·00

It will be seen that, with the exception of the small area about Iceland, all the differences are positive; or the barometer stood higher on February 7, 1875, at 7h 35m. A.M. W. M.T., than on the 27th at the same hour. I have no doubt that when the investigation is made with the care it merits, much more marked results will be obtained. All these series, however, with the exception of the last two stations, are in the northern hemisphere; it is then of course possible that the atmosphere was playing at "hide and seek" with us, and had moved away to places for which no observations are at present forthcoming. There may also have been some difference in the amount of vapour in the air on these two days; this I have not attempted to calculate, but for two days in February, in the northern hemisphere, it will probably be very small.[1]

In the first investigation already referred to, I had calculated the mean tension of vapour in the lowest stratum of the atmosphere for each station; this, it is now agreed, does not indicate the pressure of vapour on the barometer, but the result was that the vapour tension was greatest in July, when the mean barometric pressure was least. A reason for the increased mean vapour tension for the whole globe in July will be found in Dove's result that the mean temperature of the whole atmosphere is greatest in that month. I shall probably take the liberty of returning to this subject.

JOHN ALLAN BROUN

[1] I see from the *Bulletin* in my possession (that for February 7) that the thermometer was, on the average, below zero (centigrade) in Europe, and from 10° to 30° below zero in America; the higher pressure on the 7th could scarcely then be due to the vapour in the air. For any considerable exactness in such comparisons, series of observations like those of General Myer should contain the *observed* pressures for each station (or the correction to the sea level) as well as the calculated sea-level pressures; since if, at any high level station, the observed pressures are *exactly the same* on two days one of which has a higher temperature than the other, the calculated pressures for the sea-level will differ, that for the lower temperature being highest. The greatest mean error due to this cause in the present instance will not, in all probability, exceed ±0·01 inch.

PRINCIPLES OF TIME-MEASURING APPARATUS[1]

III.

Clock Escapements.

AN escapement in general is to be considered a good one just in proportion as it prevents variations of friction in the clock-train from reaching the pendulum.

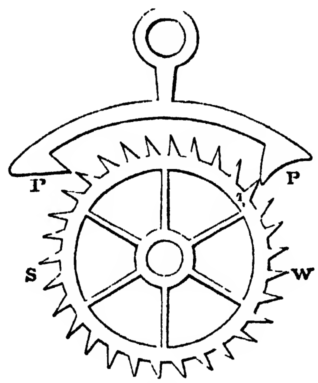


FIG. 14.

The first form of escapement with which the pendulum was used is that early form mentioned in our description of the clock from Dover Castle; but this was speedily abandoned on account of the unduly large arc through

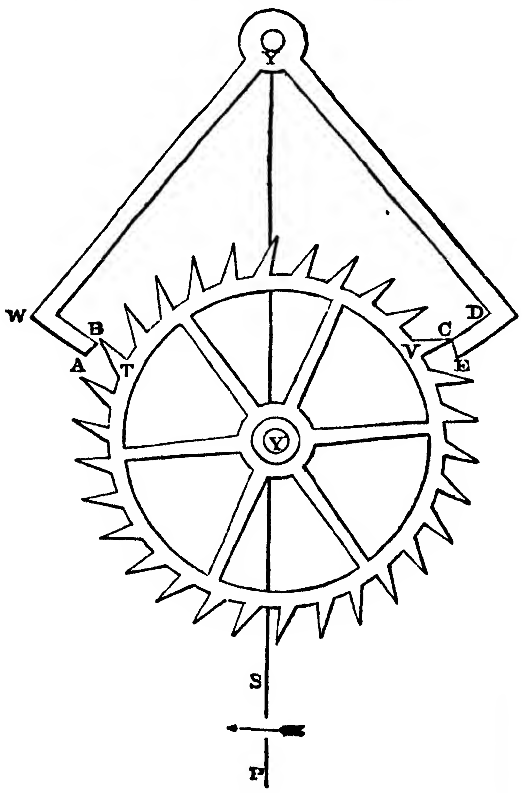


FIG. 15.

which the pendulum had to swing in order to liberate the teeth of the escape-wheel. The form next employed is that shown in Fig. 14. The principle is nearly the same, except that the pendulum need only swing 2° or 3° in order that the teeth may pass.

S W is the escape-wheel. The tooth T is now being held by the right-hand pallet, P; in point of fact, as the pendulum is swinging to the left, the pallet is actually recoiling or driving it back a little. By-and-by the pendulum will return, lift the pallet, and allow the tooth to escape, when the same action will take place upon the opposite pallet. You can readily see what the effect would be, supposing a little more force to be occasionally transmitted by the clock-train; it is obvious that the pendulum would be beaten backwards and forwards by the action of the pallets, and the time of the clock would be greatly accelerated. The reverse action would take place supposing a little less force to be transmitted. This escapement is called the recoil escapement.

We now come to the dead escapement (see Fig. 15), invented by the same Graham who discovered the mer-

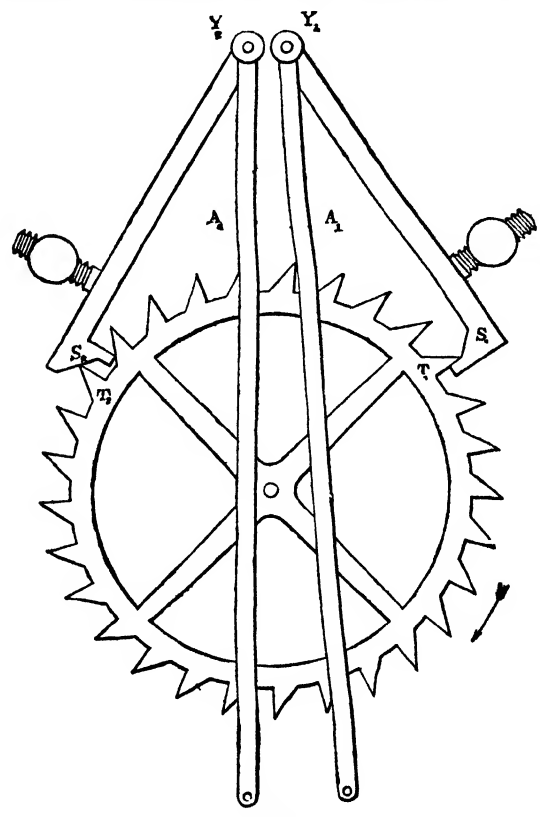


FIG. 16

curial pendulum. The escapement is so called because, during the greater part of the swing of the pendulum, the seconds hand lies motionless or dead, upon the division of the clock dial.

That tooth T of the escape-wheel has just got clear of the left-hand pallet, and V has fallen upon the face C D of the right hand. W A and C D are portions of circles described from Y, the axis of motion of the pallets, and you see they have therefore no tendency to drive back or recoil the escape-wheel.

In order to understand its advantage, I must ask you to follow very carefully what I am now going to say. As I told you when we were discussing barometric compensation, any force acting upon the pendulum in the same direction as gravity, will cause it to swing faster, and any force against gravity to swing slower. The force of the clock train, when it gives impulse to the pendulum, may act either *with* or *against* gravity; that is to say, it may

[1] Lectures by Mr. H. Dent Gardner, at the Loan Collection, South Kensington. Continued from p. 556.

be given when the pendulum is *falling* or *rising*. In the first case any variation in the friction of the clock-train tending to increase the impulse will make the clock gain, in the second, to make the clock lose. But why could we not so arrange an escapement that the impulse should be given, half when the pendulum is falling, and half when it is rising? and then any variation in the force of the impulse will simultaneously cause the clock to gain and lose, and so correct itself.

This is what can *nearly* be done in the dead escapement, but not exactly, because the condition of so doing is that each tooth of the escape-wheel, shall drop exactly upon the corners C and A, dividing the dead faces C D, W A,

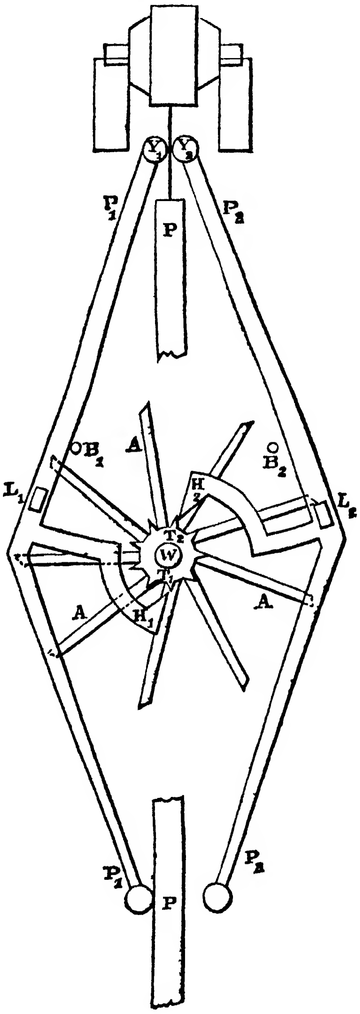


Fig. 17.

from the impulse faces C E, A B, and you are bound to allow a little margin for safety. But just in so far as this condition is fulfilled, so the escapement is a good one.

Gravity Escapements.

To understand the principle of these you cannot do better than refer to Fig. 16, which shows the original form invented by Mudge. The tooth of the escape-wheel T_1 by operating upon the slant S_1 has lifted the pallet $S_1\ Y_1$ to its present position, and the tooth is now being held by the hook at the end of the pallet. The pendulum, which is detached from the pallets, is advancing towards the arm $Y_1\ A_1$ connected with this pallet, and will by-and-by lift it, freeing the escape-wheel: the other tooth of the wheel will then operate upon the slant S_2, of the other pallet $S_2\ Y_2$, and lift that until it is in turn detained by the hook at its extremity. Meanwhile the pendulum carries the first pallet to the extremity of its swing, and then returns with it; but as there is now no tooth in the way to receive it, the pallet $S_1\ Y_1$ will drop, until it occupies a corresponding position to that in which the pallet $S_2\ Y_2$ is at present situated.

Thus you see the pallet falls upon the pendulum a greater distance than the pendulum lifted it, and this difference—the weight of the pallet multiplied into this space—forms the impulse. This impulse, of course, is constant, and any variation in the force of the clock-train will only cause either pallet to be lifted with greater or less rapidity.

This escapement used to "trip," that is to say, that occasionally the pallets were lifted with so much rapidity, as

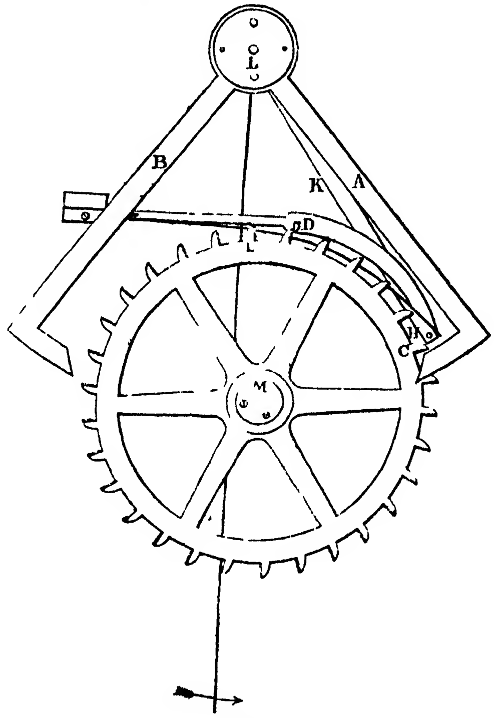


Fig. 18.

to be thrown completely away, and then the hooks at the extremities of the slants failed to catch the escape-wheel teeth, and the wheel ran on (apparently making the clock gain).

This escapement was improved by the late Mr. Bloxam,[1] who put cogs near the axis of the wheel to do the lifting, which was thus effected more slowly (see Fig. 17).

That collection of arms, A A A, and the cog-wheel, W, to which they are fastened form the escape-wheel. The pendulum, P P, is now passing through the vertical position or zero, and the pallet $P_1\ P_1$ has fallen as low as it can, and is resting upon the banking pin B_1. But the other pallet, $P_2\ P_2$, has been lifted, and is now being held by the cog T_2, the cog can lift it no further because one of the arms, A A A, is caught by the locking stud L_2 (which is situated upon the opposite side of the pallet). By-and-by, however, the pendulum will reach the pallet, push it away,

[1] Mr Bloxam discovered that the pendulum should quit and take up each [illegible] depending upon its arc of vibration The reader who wishes for further information cannot do better than consult Mr Bloxam's elaborate paper, *Memoirs* R.A.S, vol xxii p. 103; and another, vol. xxvii. p. 61.

and liberate the wheel; the cog T_1 will then immediately operate upon the hook H_1 and lift the other pallet. Meanwhile the pendulum swings away to the right, carrying the pallet $P_2 P_2$, and returns with it, but as there is now no cog P_2 to receive it, it falls to the lower position corresponding to that now occupied by $P_1 P_1$, the excess of its fall over its rise, upon the pendulum as in the preceding case constituting the impulse.

This form of gravity escapement has been further modified and improved for ordinary use by Sir Edmund Beckett.[1] The only way in which variations in the force of the clock-train can disturb the pendulum in these escapements is by putting more or less pressure upon the locking studs, giving the pendulum more or less trouble in liberating the escapement; and with reference to this you must not be deceived by so-called improvements for detaching the pendulum completely from the escapement, for they really never do so, and generally by the number of pieces employed, hamper the pendulum with much more friction than that to which it would be exposed by direct communication with the clock-train.

You will see that the general effect of a gravity escapement is to make the pendulum move rather faster than if it were a free one, because the weight of the pallets is equivalent to two smaller pendulums attached to it during the greater portion of its swing. And the effect of any increase of pressure is quite the reverse of what would happen with a direct escapement, for it increases the pressure upon the lockings without increasing the impulse, and will consequently cause the arc of vibration to fall off.

The last clock-escapement I shall describe is a detached one (see Fig. 18), the design of the Astronomer Royal, Sir George Airy.

There is only one pallet, A, the other arm, B, being merely a safety-catch and counterpoise. That tooth of the escape-wheel, C, is not really resting upon the dead face of the pallet, though it is very close to it, the wheel being at present held by the detent, D, fastened to the clock frame.

The pendulum is supposed to have reached the limit of its excursion towards the left, and to be now returning. When it reaches a certain angle before zero, a pin, H, in the arm K (which swings with the pendulum and pallets), passes under the detent, lifts it, and unlocks the wheel at just that instant that the tooth C shall fall immediately upon the *impulse face* of the pallet without touching the dead face at all. The tooth slides down the impulse face, giving impulse to the pendulum; meanwhile, the pin H passes on and allows the detent to fall in time to catch the succeeding tooth L. The tooth quits the impulse face when the pendulum is at the same angle after zero that it was at before zero when the impulse began. Thus you get an equal impulse when the pendulum is falling as when it is rising, the advantage of which I pointed out to you when we were discussing Graham's dead escapement. Besides this, you get no dead friction, and the pendulum is almost completely detached from the clock-train. Upon returning the pin H clears the detent this way. You see that long spring beneath the detent, commencing near its middle, and projecting beyond its extremity upon the right; just now, in unlocking, the extremity of the detent supported this spring, and detent and all gave way before the pin H. But upon returning, the extremity of the detent of course gives no support to the spring, and the pin H pushes it upon one side without disturbing the detent. This escapement is used in the normal sidereal clock at Greenwich.

(*To be continued.*)

[1] The Westminster Clock has one of his forms. A locking stud is placed upon the back of one pallet and the front of the other, and there are two collections of arms (of three each) on either side of the cog-wheel, to meet them. The cog-wheel itself has also three cogs. This escape-wheel, with a seconds pendulum, turns once in six seconds, and its velocity is controlled by a fly.

CHARLES SAINTE-CLAIRE DEVILLE

M. CHARLES SAINTE-CLAIRE DEVILLE, the distinguished geologist and meteorologist, and brother of M. Henri Sainte-Claire Deville, the well-known chemist, was born of French parents in 1814, at St. Thomas, in the West Indies. At the age of 19 he was enrolled a pupil of the School of Mines, in Paris, and after a course of study there undertook, at his own expense, a scientific expedition extending from 1839 to 1843, to the Antilles, Teneriffe, and Cape Verd Islands. He spent upwards of a year investigating the geology of Guadaloupe, and wrote a detailed account of the terrible earthquake which laid waste that island in 1843. The results of this expedition he published in two series of memoirs, the one appearing from 1856 to 1864, on the geology of the Antilles, Teneriffe, and Cape Verd Islands, and the other from 1861 to 1864, principally on the meteorology of the Antilles. He was sent by the Institute to Italy in 1855 to examine the great eruption of Vesuvius which occurred in that year. After attentively following and investigating the eruption through all its phases, he wrote a description of it in a series of letters addressed to M. Élie de Beaumont, which were published in the *Comptes Rendus* and the *Moniteur* during 1856. He also, in 1858, published an interesting account of the volcanic eruptions of Stromboli, in the Lipari Isles, and in later years, various papers on other volcanic eruptions. Several memoirs on different points in chemistry and physics were written by him about 1852, and for several years he filled with distinction the chair of geology in the College of France, formerly held by the illustrious Élie de Beaumont. On December 28, 1857, he was elected a member of the French Academy of Sciences in the place of Dufrenoy, and on August 13, 1862, was made an officer of the Legion of Honour.

During the time he worked in the laboratory of his friend M. Dumas, he discovered the amorphous and insoluble form of sulphur, thus pointing out for the first time the fact that an elementary body may at will be made to assume two totally distinct states, differing from each other not only as regards their physical characters, but also as regards their essential chemical properties. This discovery was published in 1852.

Shortly after this his attention began to be more decidedly attracted towards meteorology; so much so, indeed, that for the past twelve years he appears in his writings almost exclusively as a meteorologist. Indeed the meteorological work, both scientific and administrative, which he undertook to do, and which he did, was so laborious and harassing as to leave him little time for other pursuits. By this work, however, he has left his mark unmistakably on the meteorology of France.

The fruits of his meteorological researches were given to the world in a remarkable series of papers in the *Comptes Rendus* during 1865-67, on the "Periodic Variations of Temperature." The object of this investigation was to prove the existence of annual and super-annual periodic perturbations of temperature, and to state with precision the character and nature of these periods. Having shown the occurrence of similar perturbations of temperature on four days of the same date in February, May, August, and November, these days being placed on the terrestrial orbit at equal intervals, and which, by the way, correspond with the dates of the festivals of the "Ice Saints," he inquired how far similar perturbations occur on any four days of the year separated from each other by equal intervals of time. Since the observations showed that some years and groups of years presented for the same days perturbations different from those of other years, being sometimes above and sometimes below the normal means of the days, an inquiry was raised as to the limits of the antagonism thus disclosed both as regards the amount and the cycle of years it embraced. Lastly, since these perturbations, if they exist, must exercise an important influence on all the

other atmospheric conditions, the still larger inquiry was suggested, viz., the sifting and separation of the facts so as to make them disclose the nature and limits of this influence in each particular class of meteorological phenomena. The theory advanced to account for these perturbations was that first suggested by Erman of Berlin, by which they are considered as due to different streams of meteoric matter which are periodically interposed between the earth and the sun—a theory which in view of the facts is open to serious doubt. But the great value of these memoirs lies in their suggestiveness and in the important lines of meteorological inquiry therein pursued and indicated. Indeed the author states that a main object he had in view would be gained if he thereby enlisted the younger meteorologists to aid in establishing clearly in meteorology the notion of periodicity, which in truth is only another name for law and harmony, the evolution of which from facts apparently so entangled and so discordant is the problem presented by meteorology. It may be added here that his two daughters materially assisted him in the laborious calculations for this work. He subsequently wrote various papers on the connection between atmospheric pressure and temperature, on the aurora, and on terrestrial magnetism.

He was one of the founders of the French Meteorological Society, and it was during his term of presidency of the Society that the Meteorological Observatory of Montsouris was established chiefly through his influence and that of M. Dumas, for the special purpose of investigating terrestrial physics, inclusive of the work usually undertaken by meteorological observatories. This observatory remained under his direction from the date of its establishment in June, 1869, to June, 1872, when he was appointed Inspector-General of Meteorological Stations in France. Under his management and that of his successor, Marié Davy, the well-known meteorologist, the Montsouris Observatory has gradually come to occupy, as our readers are doubtless aware, a well-marked sphere of action which we hope similar observatories in other countries will not be slow to adopt. This special sphere of action concerns the application of meteorology to the great national questions of agriculture and public health, particularly the health of large towns; and it consists in a well-devised scheme of chemical and microscopical observations regularly conducted, having for their object the investigation of the composition of the air, more especially as regards the variations of its aqueous vapour, carbonic acid, nitric acid, and ammonia, and its organic and inorganic impurities.

As Inspector-General of the French meteorological stations, he went to Algiers for the purpose of organising the meteorological stations of that country. Owing to the fatigue incident to this journey and the inclement weather he experienced his health was impaired, and it remained in a weak state up to the last. This illness was the more severely felt by a system already enfeebled by a malady which he had contracted thirty-three years before in the service of science. When in 1843 he had just completed his three years' exploration of the volcanic isles of Africa and the Antilles, and it only remained to him to put into shape the rich materials he had collected, the great earthquake, already alluded to, of Pointe-à-Pitre, Guadaloupe, occurred, by which he not only lost the whole of his valuable collections, but was called to mourn the loss of his uncle and several other members of his family, who perished in that catastrophe. The mental suffering and fatigue consequent on these disasters brought on a rheumatic affection, from which he never recovered, and it was to an aggravated form of this malady that he succumbed on October 10, at Paris.

Thus died Charles Sainte-Claire Deville in the midst of his work—a man of singular modesty and amiability of disposition, as well as an enthusiastic worker in science. His funeral was largely attended, but in accordance with a desire expressed in his will, no official deputation of the Academy was present on the occasion, and no funeral oration was pronounced over his grave.

RECENT CAVERN RESEARCHES IN NEW ZEALAND

THE following is the substance of a paper on Cave-Hunting, by Dr. Haast, read at the Philosophical Institute of Canterbury, New Zealand, some time since, and which has been recently forwarded to us.

In the spring of the year 1872, Mr. E. Jollie having suggested to Dr. J. Haast, president of the Institute of Canterbury, that an inspection of the Moa-bone Point Cave, and of the ground near its entrance, would probably help to fix the period of the extinction of the Moas, a subscription list was at once opened, and the results enabled Dr. Haast to commence the work and to carry it on for seven weeks.

Moa-bone Point Cave is situate on the eastern side of the Middle Island, in Banks Peninsula, an extinct volcanic system of large dimensions, which is believed to have been an island in Post-pliocene times, and to have been subsequently raised about 20 feet. The cavern seems to have been a pre-existing hollow in a doleritic lava stream, enlarged by the waves during the insular period. It was well known to Europeans at the very beginning of the Canterbury Settlement, was even inhabited by some of the earliest settlers, of whom ample traces were left behind. Immediately east of the cavern is a small plain, occupied with dunes of drift sand, and bounded seaward by a line of boulders, detached from a small doleritic headland on the western side of the cave when the peninsula was an island.

The entrance to the cavern is from 13 to 14 feet above high water, 30 feet broad and 8 feet high, but is partially occupied by a mass of rock 12 feet long, 6 feet broad, and 10 feet high. This opens into the "First Chamber," which measures, from north to south, 102 feet long, 72 feet broad towards the middle, and about 24 feet high. From its inner or southern end a small passage leads into a "Second Chamber," 18 feet long in a direction N. by W. to S. by E., 14 feet wide, and 11 feet high. At the inner end of this is a passage, 3 feet high, and 2·5 feet broad, leading into a "Third Chamber," measuring 22 feet from N. to S., about 20 feet high, and averaging 16 feet in width.

The floor of the first chamber consisted generally of remains betokening European occupation, but everywhere below them were portions of shells of edible molluscs. These beds gradually thinned out southwards, till at the entrance of the second chamber there was a continuous floor of marine sand.

The explorations appear to have been almost exclusively confined to the first chamber, and to have been commenced by digging two trenches, crossing each other at right angles, near the centre of the chamber. Several other excavations were made, and in one of them, towards the western side of the chamber, the following was the succession of beds, in descending order :—

		ft.	in.
1.	European deposits	0	6
2.	Shell bed	0	9
3.	Tussock and ash beds	0	4
4.	Shell beds	1	4
5.	Ash beds	0	2
6.	Ash beds, mixed greatly with shells	0	10
7.	Ash and dirt beds	0	2
8.	Agglomeratic bed	0	6
9.	Ash bed	0	3
10.	Marine sands (excavated to a depth of 7 ft., and found by boring to extend 5 ft. deeper before reaching the rock at the bottom of the cavern)	12	0

Whilst the beds, as might have been anticipated from their characters, were neither equally numerous nor equally thick in different sections, the following important features presented themselves everywhere :—

The basal bed was uniformly the "marine sand" (No. 10); the ash and shell bed (No. 6), the ash and dirt bed (No. 7), and the agglomeratic bed (No. 8), were also well-defined horizons; the shells found in the sixth bed and those above it belonged to species still occupying the adjacent estuary, and the same forms were found in all the beds alike; there were no shells in the

seventh bed, or any below it, excepting those which the sea had lodged in the marine sand, some of which were estuarine species, and a very few valves of the common freshwater mussel (*Unio aucklandicus*), found near a "cooking oven" which had been excavated in the same bed; and the sixth and seventh beds were separated by a sharp and constant line of demarcation.

There can be no doubt that, omitting the "European bed," the facts fully justify Dr. Haast's division of the deposits into two distinct series—the "upper," or "shell-bed" series, consisting of the sixth and all the beds above it; and the "lower," of all those below it. The sharp line of demarcation separating the two sets of beds, as already stated, suggested to Dr. Haast that there had been a protracted interval of time between their deposition; and this is strongly supported by the fact that in a section at the entrance of the chamber a bed of drift sand, a foot thick, was found to separate them. It was continuous for some distance southward, but ultimately thinned out in that direction.

The aggregate thickness of the beds of the upper series varied in different sections from one foot to 7·5 feet, being thickest near the entrance, and especially under the shelter of the fallen rock; whilst that of the lower series, exclusive of the marine sand, fluctuated from 8 to 15 inches. The *relative* thickness of the two sets varied considerably in different sections, the lower being but 18 per cent. of the upper at the western end of the cross section in the first excavation, whilst each was one foot thick at the eastern end of the same section. From the data at hand it appears that on the average the thickness of the lower series was about 30 per cent. of that of the higher.

Dr. Haast's "agglomeratic" bed consists of pieces of rock fallen from the roof. Though this fall of fragments was not actually restricted to any one period, inasmuch as all the beds contain lumps and blocks of the kind, it seems to have been peculiarly prevalent during the era represented by the agglomeratic bed.

List of Objects found in the Lower Series of Deposits.

A.—REMAINS OF MAMMALS.

Bones of Man	1
,, Ziphoid Whales	8
,, Sea Leopard (*Stenorynchus leptonyx*)	39
,, Fur Seal (*Arctocephalus lobatus* (?) and *A. cinereus*)	332
,, Small Fur Seal (*Gypsophoca subtropicalis*)	27
,, Dog	43
,, Porpoise	24

B.—REMAINS OF BIRDS.

(*a*) *Extinct Birds* (*Moas*).

Bones of *Dinornis robustus*	13
,, *Palapteryx crassus*	18
,, *Euryapteryx gravis*	35
,, *E. rheides*	94
,, *Meinornis casuarinus*	17
,, *M. didiformis*	103
,, *Aptornis defossor*	1
,, *A. otidiformis*	2
Fragments of bones of different species	51
Tracheal rings of Moas	37
Trays of portions of eggshells of Moas	3

(*b*) *Recent Birds.*

Bones of Spotted Shag (*Graculus punctatus*)	107
,, Black Shag (*G. carbo*)	18
,, Pied Shag (*G. varius*)	15
,, White-throated Shag (*G. brevirostris*)	12
,, Small Blue Penguin (*Eudyptula undina*)	67
,, Grey Duck (*Anas superciliosa*)	17
,, Nelly (*Ossifraga gigantea*)	6
,, Large Kiwi (*Apteryx australis*)	3
,, Kaka (*Nestor meridionalis*)	5
,, Kakapo (*Stringops habroptilus*)	2
,, Tui, Gulls, Terns, and smaller birds	148
Feathers of Kaka	11
,, Nelly	1
,, Spotted Shag	39
,, Harrier (*Circus assimilis*)	1
,, Undetermined	5

C.—REMAINS OF FISHES.

Bones of Hapuku (*Oligorus gigas*)	39

D.—REMAINS OF MOLLUSCS.

Tray of *Unio aucklandicus*	1
,, *Mesodesma cuneata*	1
,, *Mactra discors*	1
,, *Artemis subrosea*	1

E.—OBJECTS OF HUMAN WORKMANSHIP.

(*a*) *In Bone.*

Canine Tooth of Dog, bored at base	1
Needle made of humerus of Nelly	1
Awl ,, tibia ,,	1

(*b*) *In Wood.*

Apparatus for lighting fire, by circular motion, made of Pukatea (*Atherosperma novæ zealandiæ*)	2
Apparatus for lighting fire, by rubbing lengthwise, made of Komaku (*Carpodetes serratus*)	5
Fork, made of Manuka (*Leptospermum scoparium*)	2
Portions of apparatus for lighting fire by rubbing lengthwise, made of Patete (*Melicope ternata*)	1
,, Spear, made of Nene (*Dracophyllum* sp.)	1
,, Pile, made of Totara (*Podocarpus totara*)	2
,, Canoe (?), one made of Tawai (*Fagus menziesii*), one made of Pukatea	2
,, Bird Spear (?) made of Tawa (*Mesodaphne tawa*), a tree of the North Island only	2
Four pieces of Pukatea, and three chips of Totara	7

(*c*) *In Stone.*

Polished adze, perfect	1
,, Implements, fragmentary, one resembling the point of a tool called Tamatau by the Maoris, formerly used by them to make fish-hooks	17
"Cores" of agate, quartz, and chalcedony	4
Chipped flint implements (ten cores, two spearheads, three knives, nineteen flakes)	34
Pieces of gritty sandstone, Taraiwaka of the Maoris, some with grooves for sharpening tools	4
Four pieces of Obsidian (Tuhua), two of pumice stone	6

In addition to the objects just tabulated, three "cooking ovens" belonging to the lower series of beds were met in the First Chamber. After serving as ovens they were converted into kitchen middens.

Returning to the list of objects of interest: the human bone was a portion of the right ramus of a lower jaw of an individual probably not quite mature. It was found six inches deep in the marine sand, and may have been carried in by the surf, as it lay near the greater portion of the skeleton of a fur seal, which had doubtless been washed in.

The very few valves of the freshwater mussel already mentioned were the only indication that the men of the era of the Lower Series of beds made use of molluscs or their shells. All the other molluscous remains were without doubt washed in by the waves of the sea, and lodged in the marine sand where they were found. The favourite and chief food of the period was obviously the Moa, of which at least eight species belonging to five genera were thus utilised; though, as the table distinctly shows, smaller birds were by no means despised. As no portions of skulls were found, with the exception of very small fragments, it has been inferred that the brain of the Moa was considered a great delicacy. The leg-bones were usually broken, some were calcined, whilst others were in a splendid state of preservation. None of them were gnawed, and even the smallest of them were, without exception, quite intact, except such as had been cut or broken by man; a fact especially noteworthy, as the table shows that there were contemporary dogs. Dr. Haast's earlier researches had led him to the conclusion that the Moa hunters had chased the dog for food, but had not domesticated it. There can be no doubt that this view is considerably strengthened by his recent labours.

There is now satisfactory evidence that the men of the Lower Series used *polished* stone tools as well as such as were merely *chipped*.

The bone needle was 4·25 inches long by ·2 inch broad, and is believed to have been used rather as a bodkin to carry a thread through holes made by the awl. The perforated canine of dog was no doubt worn as an ornament.

Bones of Moas and of other birds presented themselves at very slight depths in the marine sand in the second and third chambers, mixed with ashes and other signs of human occupation.

List of Objects found in the Upper Series of Deposits.

A.—REMAINS OF MAMMALS.

Bones of Man ...	3
,, Ziphoid Whales ...	12
,, Porpoise ...	9
,, Dog ...	51
,, Sea Leopard ...	11
,, Fur Seal ...	37
,, Small Fur Seal ...	19
,, Rat ...	3

B.—REMAINS OF BIRDS.

(*a*) *Extinct Birds* (*Moas*).

Small pieces of Moa bones, bleached and decomposed ..	7

(*b*) *Recent Birds.*

Bones of Spotted Shag ...	104
,, *Graculus* sp. ...	17
,, Grey Duck ...	8
,, Harrier ...	3
,, White Crane (*Ardea alba*) ...	2
,, Paradise Duck (*Casarca variegata*) ...	3
,, Large Kiwi...	2
,, Nelly ...	1
,, Small Birds not yet determined ...	37
Feathers of Spotted Shag ...	62
,, Kakapo ...	49

C.—REMAINS OF FISHES.

Bones of Hapuku ...	164
,, other Fishes not yet determined ...	37

D.—REMAINS OF MOLLUSCS.

Tray of Mussel (*Mytilus smaragdinus*), numerous ...	1
,, Cockle (*Cockle stutchburyi*), numerous ...	1
,, Pipi (*Mesodesma chemnitzii*), numerous ...	1
,, *M. cuneata*, numerous ...	1
,, Periwinkle (*Amphibola avellana*), numerous ...	1
,, Kokotu (*Lutraria deshayesii*), about thirty lying together ...	1
,, *Mactra discors*, a few ...	1
,, *Voluta pacifica*, a few ...	1
,, *Unio aucklandicus*, a few ...	1
,, *Haliotis iris*, a few ...	1

E.—OBJECTS IN WOOD, BONE, OR FIBRE.

Pieces of a Toa, a long thin spear made of Tawa, to shoot birds with. At the upper end a barbed point, called Tara, was fastened, made of human or bird's bone ...	6
A Manga Oko-oko, a wooden fish-hook, made of Pukatea, with a small piece of whale's tooth, called Mata, standing backwards ...	1
Patu aruhe, fern-root pounders, four made of Maire (*Santalum cunninghamii*), a strictly Northern Island tree, and one made of Akeake (*Olearia* sp.) ...	5
Fragments of a Matiha Tuna, fork for spearing eels, made of Manuka ...	4
Portion of a Kaho, batten for a whare, made of Turepo (*Hoheria populnea*), ribbon wood ...	1
Portions of several Whaka kai, wooden dishes for preserving fat and juice ...	13
Taka ore kaka, parrot stands, made of Pukatea ...	2
Pu-tatara, small trumpet, made of a Struthiolaria shell ...	2
Mata, mouth of a flax bag, made of twisted thin sticks, for preserving birds after being cooked ...	1
Taka kai, matting used for covering the food in the hangi, or oven, to keep it clean ...	2
Parenga-renga, sandals made of flax, or Ti-tree leaves ...	3
Pawa shells (*Haliotis iris*), in which the holes at the exterior border were filled with flax, for keeping oil ...	4
Pieces of nets: the floater of pumice-stone is called Poito	4
Matao, fish-hooks, for catching Hapuku, made of Kaikaiatua (*Rhabdothamus solandri*), a Northern Island tree	4
Fish-hook, made of Rata (*Metrosideros*) ...	1
Piece of timber, of Pukatea ...	2
Karera, a wooden handle made of Totara, to fasten a piece of greenstone to be used as a chisel ...	1
Portion of a Patu-patu, a large wooden hammer ...	1
Tahatiti-whaka, a squared piece of wood (Totara), to fasten the sides of a canoe ...	1
Puru, made of Manuka, a pin to stop the holes of a canoe for letting water out ...	2
Kauhuhua, a wooden pin, made of Manuka, to fasten the battens across the canoe ...	2
Tokai, a thin long stick, used to keep the mouth of the fishing-net open ...	2
Ripipawa, a knife made of Manuka, to loosen pawa shells	1
Pieces of Matiha, fighting spear, made of Manuka ...	6
Pieces of timber, portions of mats, cordage, &c. ..	53
Portion of Korapu, net for catching Inangas or Whitebait	1

F.—OBJECTS IN STONE.

Portions of polished stone implements ...	3
,, ,, greenstone ...	1

Among the objects belonging to the era of the beds of the Upper Series, though to a comparatively modern portion of it, was a human skeleton which had been carefully interred. It was detected a few feet from the south-western wall of the First Chamber. The grave had been dug through all the deposits then existing, several feet deep into the underlying marine sand. The body was in a sitting posture, tied together with flax, the face toward the south-west, and it was covered with part of the sand which had been thrown out of the grave; the remainder, as well as the overlying beds which had been dislodged, being thrown around the spot. It was clear that the ground had afterwards been levelled, and that about six inches of shell-bed, level and continuous in all directions beyond the disturbed area, had been subsequently deposited over the grave, whilst over this again lay the European bed, three inches thick. The skeleton is that of a man nearly six feet high, and certainly not young.

It was evident from the accumulations deposited after the interment that the burial had taken place before the arrival of Europeans, and that during the interval the natives continued to frequent the cavern and to take their meals there. The latter fact leads to the inference that its occupation was not constant or even regular, but occasional only and by different tribes; for, judging from the character and superstitions of the existing natives it may be safely concluded that after the burial of one of them the cave would have become strictly *tapu* to all those having any knowledge of the fact, at least so far as taking a meal there is concerned.

On comparing the lists of objects found in the two sets of deposits, the facts which probably most strongly arrest attention are, (1) the presence of Moa bones in the Lower Series, but not in the Upper; and (2) that whilst the upper beds consist very largely of estuarine shells, it may almost be said that in the lower there are no traces of shells introduced by man. When the mind is in addition directed to the condition of the bones of the various species of Moa, as well as to the further fact that the valves of the bivalve shells were almost invariably disunited, there can be no hesitation in accepting Dr. Haast's name of *Moa-hunters* for the men of the Lower Series, and of *shell-fish eaters* for those of the upper. The Spotted Shag and the Dog appear to have been favourite dishes in each period.

The human remains mentioned in the second table were two pelvic bones of a full-grown male, and the ninth dorsal vertebra of a subject not quite mature. As they were all entire, and were the only relics of the human frame found throughout the whole thickness of the beds, Dr. Haast is of opinion that during all the time the shell-fish eaters were in possession of the ground they were either not addicted to cannibalism, or their relations with neighbouring tribes were of so peaceful a character as to afford them no opportunity to indulge in that horrible practice. Looking, however, at the great lapse of time represented by the shell accumulations, and the insecurity of life amongst savage tribes, he believes that had they been cannibals when, at least, the lower shell beds were formed, there would have been some evidence of the fact.

Excepting the Fur Seal (*Arctocephalus lobatus*) as of doubtful identification, the two lists of mammals differ only in the occurrence of the rat in the shell beds, where, however, there were but three of its bones. Its presence was further attested by its teeth-marks on many of the bones, and by its holes passing through the upper beds. A few of the bones had been gnawed by dogs, whence it may perhaps be inferred that the shell-fish eaters had effected its domestication.

Dr. Haast supplements the description of his cavern researches with a brief account of his labours amongst the sand dunes in the adjacent plain. Numerous cooking ovens occurred

amongst them, where they were often close together, and, like those in the cavern, appear to have been ultimately filled more or less with the refuse of feasts. A clear line of demarcation was found here also between the deposits of the Moa-hunters and those of the shell-fish feeders, and, except in one instance, where a few pieces of the fresh-water mussel were met with, no shells occurred in the older series of deposits. Judging from the greater number and volume of the kitchen middens found in the small area examined, there can be no doubt that the real camping ground of the Moa-hunters was on the plain, and that they used the cavern occasionally only for shelter or for their meals, and very rarely for cooking. It seems most in accordance with the facts, also, to suppose that the shell-fish eaters lighted fires in the cavern for warmth and light, and that they probably slept there, but that, like their predecessors, they cooked their food outside.

Dr. Haast gives a tabular list of the objects collected in the Moa-hunters' middens amongst the dunes, but it is to a very large extent a repetition of the contemporary cavern list.

Dr. Haast is of opinion that the time represented by the cavern deposits was very great, and, in support of his view, directs attention to the following facts and considerations :—

1. That the mere volume of the shell-beds alone must have a great chronological value, on any hypothesis.

2. That this value is greatly enhanced by the fact of the cavern being but occasionally occupied.

3. That even the occasional visits were probably suspended during a considerable interval after the interment of the Maori.

4. That on the inner or westerly portion of the adjacent plain there is a remarkable number of shell heaps, belonging to the era of the upper series of deposits, which the natives attribute generally to the Waitaha, the first immigrants, who preceded the Ngatimamoe, who in their turn preceded the Ngatikuri, the present inhabitants.

5. That though the cannibalism found in New Zealand when first discovered by Europeans had been practised for at least several centuries, there is an almost entire absence of human bones even in the shell beds, whilst the three solitary specimens of this kind which were met with were so entire and perfect as to negative the idea that the men of even that comparatively modern period were cannibals; and that the same view is borne out by a study of the Moa beds.

6. That as far back as the traditions of the Maoris go, allusion is made in their songs to the Weka (*Ocydromus australis*); yet amongst the hundreds of bones belonging to small birds, not a vestige of the Weka was met with in any of the deposits.

7. That beyond the vast period covered by the shell beds was that interval represented only by the uniform sharp line of demarcation between the two sets of deposits, by the intermediate layer of drift sand, by the disappearance of at least eight species of Moas, and by the strongly marked change in the food of the natives.

8. That since the extinction of the Dinornis and its contemporaries there has been a period sufficiently considerable for the conversion of an area then occupied with large lagoon-like lakes into that part of the Canterbury Plain which is now near the sea, and for the formation of sand dunes of great width upon it.

9. That further back still was the period of the Moa-hunters, to whose deposits, due allowance being made for their somewhat smaller volume, all the considerations applied to the beds above them may be repeated with equal force.

There seems reason to believe that the civilisation of the Moa-hunters was in many respects not inferior to that possessed by the Maoris when first visited by Europeans.

It is obvious that if the entire absence of Moa remains in the shell-beds of the cavern and the adjacent dunes is to be regarded as conclusive on the point, there can be no reason for hesitating to accept the opinion that an enormous amount of time must have elapsed since the extinction of the gigantic birds in at least that portion of the island.

In more recent papers, Dr. Haast expresses the belief that subsequent researches, in other parts of New Zealand, tend to confirm his conclusions.

THE GERMAN EXPEDITION TO SIBERIA [1]

THE travellers left Saissan on May 31, and arrived in Maiterek on June 4, in the company of his excellency the governor-general of West Siberia, General Pottaratzki, whom they met two nights previous to their arrival. Three tarantassas drawn by artillery horses conveyed them from Saissan on to the shores of the black Irtisch. Their way led again through the steppe mostly covered with Dschi, a kind of short, thick grass, with here and there patches of white alkaline soil; but after some time their eyes were refreshed by the appearance of a few trees, their number increased until the country became wooded, and therefore they hoped soon to reach the river. In the evening they saw before them the banks of the stream, swelled by the recent rain into a majestic river, its waters of a yellowish brown colour. For 200 versts into China the stream is navigable for steamers, but up to this time it is not used as a means of communication. Beautiful trees bordered the river, and it was a pleasant change for the travellers, who had seen no trees since the Ala Tau, to find magnificent poplars, asps, and many other trees and bushes. Though the steppe is grand yet it becomes tedious after a while. The travellers continued their journey in a lotka (a sort of boat) belonging to a rich Kirghiz, who is one of the fishers of the Saissan Nor (Saissan Lake). The lotka was propelled by two enormous oars worked in turn by eight Kirghiz or eight Cossacks. The journey down the Irtisch was rendered delightful by the beautiful vegetation near its banks, and the abundance of birds made it a perfect eldorado for the naturalist. They were tempted to stay here, but "heida" (Kirghisian for "on") was the call, which they had to obey. Gradually the strength and width of the river decline as it gets narrowed in by dense masses of reeds. In the evening they reached the settlements of some fishermen, resembling those seen in Norway—here as there frames for drying the fish, here as there the same disagreeable smell, so attractive for the black Milans, of which they shot a specimen of the Indian variety. A quantity of fish was caught, amongst them splendid specimens of a kind of Coregonus, carp, barbel, and sturgeon, the roe of which is prepared as caviare. Towards evening they landed amidst dense reeds.

Early on June 2 an excursion to the neighbouring lake was made. On the banks were a good many persons fishing, and numbers of birds—amongst them the East Indian kind of the bald eagle (*Haliætus leucoryphus*), sitting in pairs on the trunks of dead trees—were animating the shores of the river and the reeds. About half-past seven—sunset—they landed; Kirghiz with camels and horses were awaiting them, and they proceeded on their journey over the most desolate steppe imaginable towards the north. This steppe was very stony and sparsely covered with vegetation; only at the outskirts the crippled brushwood of the Saik-Saul, of a myrtle-like appearance, was to be found; further on nothing but bare gravel; eye-witnesses told the travellers that the appearance of this steppe was quite analogous to that of the desert of Gobi. For seven hours' march there was no water, although in spring this steppe is quite impracticable as the water then flowing down the mountains forms ponds and swamps in the loamy parts. Often they passed the dry beds of such ponds, looking like mosaic by reason of the frequent and regular cracks in the dry mud. Here the spermophilus was met with for the first time, and later on three kulans, the wild solipede of these parts of Asia (more horse than ass), accompanied by a young one. Never were the mirages seen more beautiful than on this steppe, though occurring every day, here were splendid blue lakes with trees on the shores so distinctly that they could fancy them to be real. Several other times Saiga antelopes were seen and kulans, once seven at a time, but none were obtained. At last they came to a depression and found a bad but welcome spring; they rested here for a few hours. On proceeding they had soon to pass through a hilly country covered with slate. This part was interesting for the geologist: granite followed immediately upon slate, then slate and granite, after this quartz, white and grey, and with this a coarse-grained sandstone. On June 4 they reached the outlyers of the Altai; here they saw a numerous fauna and many settlements of the Kirghiz with their cattle. The outlyers consist of granite, crystallised slate and a hornblend porphyry, they are fantastically shaped but quite bare, yet not without some picturesque beauty. The zigzag road led up hill At last they saw in the distance a lovely valley with green trees, and with the joyous cry of "Maiterek" the Kirghisian guide galloped downward, followed as fast as possible by the others, to a yurt camp, situated in a wood of aspen trees near a murmuring rivulet. This was the place where the governor-general was expected, and at last, accompanied by many Kirghiz, his excellency the governor arrived with a large escort, including ladies. A friendly welcome was exchanged, and

[1] Abstract of the third and fourth letters dated from Maiterek, June 5, and a valley in the Tau Teke Mountains, in the Chinese Altai, June 11, respectively. Continued from p. 545.

after having rested a little while the whole procession moved onward, as fifteen more versts lay still between them and Maiterek.

The travellers proceeded on their journey towards the Altai in the company of the governor-general, his wife, and daughter, on June 6. The weather was most unfavourable from their departure up to their arrival in the Altaian Staniza on June 11, and now they had to undergo all the hardships from which travellers have more or less to suffer. The roads they had to traverse led nearly always along the steep narrow banks of rapid mountain streams, or along the verge of a threatening abyss, or they crossed over vast accumulations of snow filling up the ravines.

On the summit of the pass, about 6,000 feet high, covered with grass as yet undeveloped, was a spendid view of the distant Saik Saur mountains behind Saissan; a pale yellow line extended from these up to the horizon like the ocean, it was the steppe. Beautiful meadows covered with yellow and purple pansies were discernible in the valleys between the plateaus, wooden Kirghisian tombs, somewhat resembling log huts, gave to the whole the appearance of an Alpine landscape. It was strange to see the mole (*spalax*) burrowing at this height, where trees—even the hardy larch tree--had disappeared. One night's rest was spent in a yurt camp near the lake Marka Kul. They approached it along the steep shores of the river Kuldschir, the sole outlet of the lake, and one of the tributaries of the black Irtisch. The view here was delightful, the lake of an azure colour, surrounded on all sides by mountains rising 1,500 feet above its surface, covered with snow, and partly wooded. The banks of the lake are very steep and indented here and there with deep bays. With their nets they secured many fine fishes, which, apart from their scientific interest, were welcomed as a pleasant change to their every day fare of mutton. There is an abundance of fish in the Marka Kul, but it is caught only by the Chinese Kirghiz and the Russian Altaian peasant, and that in a very primitive way. Generally they divert one or other of the small tributaries from its cour.e, and the fish remaining in the dry bed are caught.

In spite of the dangers of the roads, the governor's wife had availed herself of every possible opportunity to photograph the most beautiful parts of the wild mountain scenery about them: this excellent horsewoman rode without fear or giddiness, never dismounting even at the most dangerous places.

The travellers resumed their journey on June 9, but the bad weather still followed them; they passed through large virgin forests, along the borders of abysses nearly 1,000 feet deep; at last they camped on a green meadow facing the Tau Teke Mountains (Steinbock Mountains), so called on account of the numbers of Steinbock found there. Early on June 11 a Steinbock hunt was attempted, thirty Kirghiz on horseback acting as drivers, but they did not get anything. On going on, in about an hour they reached the top of the pass, the Burchat; here they saw two cairns with poles before them, the Chinese frontier poles, and now they left the Celestial Empire and rode on into Siberian territory, slowly descending from the height of about 8,000 ft., where trees cease to grow; the descent soon became steeper and steeper, and at last so rapid that even Cossacks and Kirghiz were obliged to dismount. When they reached the plain they were surprised to see the vegetation, trees, bushes, and flowers, so much richer than at the Ala Tau. Also in this camp the governor was welcomed by a deputation of Kirghiz, and after a short rest they rode on to the Altaian Staniza, a military post.

NOTES

On the 25th ult. there was unveiled at Copenhagen a bronze statue to H. C. Oersted, the discoverer of electro-magnetism, who died twenty-five years ago. The monument, erected on a terrace of the old fortification, consists of a hexagonal pedestal surmounted by a statue of Oersted, and on which are three female figures representing the Past, the Present, and the Future. Oersted has in his hand the wire of an electric battery which he holds over a magnetic needle. The ceremony of unveiling was attended by the King of Denmark, the King of Greece, the Crown Prince, most of the ministers and diplomatic officials, professors and students of the University, and many other official, learned, and scientific men. The address was spoken by Prof. Holten of the Polytechnic, who sketched the private and scientific life of Oersted, and referred specially to the great discovery, first published in a small Latin pamphlet on July 21, 1821.

It is fitting that we should record here the death of a modest but devoted student of science, Dr. Thomas Strethill Wright, of Edinburgh, at the age of 58. Dr. Wright was a practising physician in Edinburgh, but found time to make many researches, and probably a few discoveries, in various departments of science, both in biology and physics. From a memoir in the *Scotsman*, we learn that after settling in Edinburgh in 1853, he undertook a series of observations on British zoophytes, more especially those inhabiting the Firth of Forth, and not only discovered many important facts in their structure, but added to the British fauna several new and interesting forms. His memoirs on these animals, eighteen in number, were published in the *Annals of Natural History*, the *Edinburgh Philosophical Journal*, and the *Proceedings of the Royal Physical Society* of Edinburgh, and speedily attracted the attention of scientific workers in the same field both at home and abroad. He entered into a correspondence with Agassiz, Van Beneden, Claparède, Kolliker, and Allman, who in their writings repeatedly refer to the value of his observations and discoveries. But he did not confine himself to natural history studies. He was constantly at work with physical apparatus, and invented various singular forms of telephones, &c. Some of the most curious of his experiments on what he called Electric Cohesion Figures are described by himself in *Chambers's Encyclopædia*. But it is much to be feared that a great many of his most ingenious inventions and discoveries are entirely lost, as his modesty prevented him from bringing them before the Royal Society of Edinburgh, though he was frequently urged to do so. One of these was a mode of studying the scintillation of stars by observing them through a telescope of low power supported on a vibrating stand. In 1865 Dr. Wright was made a member of the Zoologico-Botanical Society of Vienna. His ingenuity and readiness showed themselves in the mode in which he constructed out of simple materials a piece of apparatus, or devised a new method of observation, or executed the beautiful drawings with which his natural history papers are illustrated.

The Queen has acted justly and generously in granting to the widow of the late George Smith a pension of 150*l*. It is stated that Mr. Hormuzd Rassam will succeed the late Mr. Smith in his work of exploration in the East. A firman for two years has been conceded to Mr. Rassam.

The Cavendish College, Cambridge, will be opened to-day by the Chancellor of the University, the Duke of Devonshire. The building when complete will be capable of accommodating 300 students. The objects of the college are—1. To enable students somewhat younger than the usual age to go through the University course. 2. To give a special training in the art of teaching to those students who desire to become schoolmasters. 3. To attract poor students by reason of the economy in cost of living. The College charges will be 84*l*. per annum, which will include tuition, University dues, board and lodging—in fact, everything but books and clothes. The residence will be nearly forty weeks during the year.

The death of M. Lick, the well-known founder of the Californian University and Observatory is reported by an American paper as having taken place on October 1. Some difficulties are anticipated in the adjustment of the donation which amounts to 5,000,000 of dollars.

For the intended Liebig memorial the sum of 140,000 marks has been already obtained. Both Munich and the little town of Giessen, where Liebig began his important researches, memorials.

THE following changes are proposed to be made in the constitution of the Council of the London Mathematical Society for the ensuing session :—Lord Rayleigh to be president in succession to Prof. H. J. S. Smith, who becomes a vice-president, Mr. C. W. Merrifield to be a vice-president in the room of Dr. Hirst, who becomes an ordinary member of the Council. The two gentlemen who have been selected to take the place of the outgoing members, Dr. Sylvester and Mr. H. M. Taylor, are Messrs. A. B. Kempe and J. J. Walker.

MRS. CRACE CALVERT has given 700*l*. for the foundation of a scholarship of 25*l*. per annum in chemistry, at Owens College, Manchester, in memory of her late husband, Dr. Crace Calvert, F.R.S.

THE vacant Natural Science Scholarship at Exeter College, Oxford, has been awarded to Mr. Joseph Baldwin Nias, commoner, of Exeter College. The scholarship is of the annual value of 80*l*. and tenable for four years during residence.

THE following College Lectures in the Natural Sciences will be given at Cambridge during Michaelmas Term, 1876:—Gonville and Caius College—On the Physiology of Digestion and Absorption, by Dr. Bradbury; On Volumetric Analysis, by Mr. Apjohn. Christ's College—On Vegetable Physiology and Histology, by Mr. Vines. St. John's College—On the Principles of Qualitative Analysis, by Mr. Main; Instruction in Practical Chemistry will also be given; On Petrology, by Mr. Bonney; On Palæontology, by Mr. Bonney. Trinity College—On Electricity, by Mr. Trotter; an Elementary Course of Practical Morphology, by Mr. Balfour; Practical Physiology and Histology, by the Trinity Prælector in Physiology (Dr. Michael Foster), at the New Museums. Sidney Sussex College—Elementary Course of Vegetable Morphology, by Mr. Hicks. Downing College—On Chemistry, by Mr. Lewis; On Comparative Anatomy and Physiology, by Mr. Saunders.

THE soundings taken in the British Channel at the expense of the Submarine Railway Company with the steamer *Ajax*, have been completed. Not less than 3,257 specimens have been collected, and will be classified for the purpose of compiling a chart of the sea-bottom. On the 18th inst. the shaft at Sangatte had reached the depth of 122 metres; the boring, it is expected, will reach its termination, 130 metres, by the end of the month.

A SUM of 1,500,000*l*. has been allotted for the construction of the French Exhibition building of 1878. An artificial waterfall will be arranged at the Trocadero. Water will be pumped out of the Seine by colossal engines which will themselves be an attractive part of the exhibition. The waterfall will be illuminated every evening with coloured and electric lights.

AT the last meeting of the Dresden Society for Incineration, "Urne," it was announced that at the Brussels Exhibition of Hygienic and Life-saving Apparatus, the gold medal was awarded to the Siemens system. It was also announced that for the erection of an incinerating furnace in Saxe-Gotha, preparations for which have already been made, considerable contributions have been received. The agitation on behalf of incineration, it was stated, is making slow but steady progress in other countries.

A NOTIFICATION has been published by the French Government for the benefit of railway travellers, that the second and third-class carriages will be warmed next winter. The companies are at liberty to use any system they think best, but they must all adopt some system.

THE usual autumn *soirée* of the Manchester Field Naturalists' and Archæologists' Society is this year to be held in the Aquarium of that city, and is to comprise an exhibition which promises to be of a unique character. The special subject chosen is "The Mountain Limestone," and it is intended to illustrate every phase in the history of this formation, in an unusually comprehensive and attractive manner. Collectors willing to add to the completeness of the display, which it is intended to open to the general public for some days subsequent to the *soirée*, should communicate with Mr. Faraday, who is the Secretary to the Society, at the Manchester Aquarium.

THE popular impression that fair hair and blue eyes are characteristic features of German people has been confirmed by a recent census, although opinion among anthropologists has been divided on the subject. On a certain day every school in Prussia had to make a return of the black and blue and brown colour of the children's eyes. After a short time the results of this anthropological commission have been published, and they are, at all events, curious, though perhaps not of much scientific value The number of persons examined in Prussia amounted to 4,127,766. Out of that number, 4,070,923 were under fourteen years of age. With regard to the colour of their eyes, 42·97 per cent. had blue, 24·31 per cent. brown eyes. With regard to the colour of the hair, 72 per cent. had blonde, 26 per cent. brown, and 1·21 per cent. black hair. With regard to the colour of the skin, Prussia has only 6·53 per cent. of brunette complexion. In Bavaria the brunette complexion claims 15 per cent., the black hair 5 per cent., the brown hair 41 per cent., the fair hair 54 per cent.; and it is argued from this that the darker complexion in Germany came from the South. The Report contains a number of curious observations; for instance, that nearly one-third of the Jewish school-children are fair, which would certainly not be the impression left upon a casual spectator by the ordinary run of Jewish population.

THE course of lectures at the École Libre of Anthropology, established by the Faculty of Medicine of Paris in one of their buildings, is to be commenced on November 15. The scheme we announced last year is an accomplished fact. The lectures will be open to the public free of charge. M. Paul Broca will deliver lectures on anatomic anthropology; M. Paul Topinard, in biological anthropology, will lecture on the history of anthropology, the general, physical, and physiological characteristics of man, and on anthropometry; M. Eugene Dally, in ethnology, will lecture on the origin and filiation of human races; M. Gabriel de Mortillet, Sub-Director of St. Germain Museum, on prehistoric anthropology; and M. Hovelacque on linguistic anthropology. The lectures will be supplemented by demonstrations in the museums and excursions to prehistoric stations round Paris.

AT a public dinner given by the Anthropological Society of Paris, a proposal of a singular nature, signed by MM. Hovelacque, Dally, Mortillet, Broca, Topinard, and others, was circulated for additional signatures. Each of these gentlemen promises to write a will directing that his brain be sent to the Anthropological Society for inspection and dissection. It is thought that by procuring the thinking organ of persons whose habits and works are perfectly known, some light might be thrown on the laws of physico-mental organisation. The scheme having been published in several Parisian papers, has provoked a furious attack from the *Univers*.

WE have received two valuable *brochures* by P. Kropotkin on the Orography of Eastern Siberia, both being reprints from vol. v. of the "Mem. Russ. Geog. Soc." The first, "General Sketch of the Orography of Eastern Siberia," shows the main conclusions arrived at by the author after many years' study of the orography of Eastern Siberia and of the adjacent parts of Mongolia and Manchooria. He points out that a large table-land runs from the table-lands of Central Asia to Behring's Straits in the shape of an elongated triangle, forming the back bone of this part of the continent, and consisting of two terraces, a higher

and a lower, both fringed with border-ridges. Two hilly tracts accompany the table-land on both sides and are composed of many short ridges running parallel to its edges, south-west to north-east; two broad belts of high plains spread out from the foot of the hilly tracts; two belts of lowlands reach respectively the Polar Sea and the Pacific; and, finally, various ridges run in the same north-eastern direction, diversifying the surfaces of the table-lands, of the plains, and especially of the south-eastern lowlands, which are also fringed by a belt of the Pacific coast ridges. These conclusions are supported by many sections, and the broad features of the land are shown on a map representing the different orographical characteristics by special colours. Some hints are also given as to the geological significance of this structure and as to its climatic and biological importance. The rough climate of the upper terrace of the table-land makes agriculture impossible on its surface, which is covered with larix forests and with marshy meadows; the agricultural settlements are, therefore, concentrated, partly on the lower terrace, but especially on the high plains and in broad ramifying valleys which cut deeply into the table-land and radiate to the east and to the south of the Baikal lake. The well-known sharp limits between the different floras, Manchoorian, Daoorian, and Saiask-Altaian, and partly also the limits between the respective faunas, are determined by the extension of different terraces of table-lands and plains, various orographical characteristics corresponding also to special geological districts. The second paper, "Materials for the Orography of Eastern Siberia," is a chapter from a detailed orographical description of Eastern Siberia, undertaken but not finished by the author. It deals mostly with the little-known hilly tracts of the southern parts of the Jenissei province, and is accompanied by a contour-map of the country. Both papers are in Russian.

THE October number of Petermann's *Mittheilungen* contains a map of the Island of Hawaii and its famous volcano, with some data on the subject by Franz Bingham. Another map shows the recent discoveries in Africa of Stanley, Gessi, and Young.

DR. ERWIN VON BARY set out on his scientific expedition from Tripoli in the middle of August, and will by this time have reached Ghât. Dr. von Bary, in the autumn of 1875, made, at his own expense, a preliminary journey in the provinces of Tarhona and Gharian, and obtained some useful practical experience. The chief object of his undertaking is the solution of the important problem of the age and nature of the Sahara; the traveller will also give his attention to the flora of the Hogar Mountain. The Berlin Geographical Society contributes to Dr. von Bary's expenses.

NEWS has reached Stockholm of Dr. Théel's expedition, which had arrived at Dudinskoj on September 11, too late to return to Sweden in the *Ymer* with Prof. Nordenskjöld.

THE well-known African explorer, Gerhard Rohlfs, gave a lecture at Augsburg on the 17th inst., on his journey to Morocco, and his four years' stay in that little-known country. Furnished in Tangiers with recommendations by the English resident, he journeyed under many difficulties and dangers into the interior, as far as the holy city Uesan, and the capital Fez, in which he made a long stay, for without much formality he was appointed general physician to the whole of the Morocco army. In this position, and as physician-in-ordinary to the Emperor himself, and supported by the friendship of the chief Cherif of Uesan, he made investigations in the land and the people, thus opening to the civilised world a comparatively new part of the earth. Rohlfs sketched the land from the coast of the Mediterranean, and the exuberant flora of the coast-lands of the latter sea. He described it as an uninterrupted garden studded with towns and the camps of the Arabs and Berbers, to the wooded snow-mountain of the Atlas; depicted the manners and customs of the people in Morocco, and on the Oases of the Sahara, and in the holy city, Uesan, whose inhabitants claim to be direct descendants of Mohammed. Finally he described his thirty days' journey to Tunis, through the endless desert, broken only by the broad valley of dried up rivers.

THE opening meeting of the French Geographical Society for the session 1876-1877, was held at Paris on October 18, under the presidency of M. Malte-Brun. Admiral Laroncière le Noury delivered an address on the International African Congress at Brussels. Letters were received from a commission who are attempting to establish a central observatory on Mont Pio IX. in the Apennines. They propose to render that establishment the centre of European meteorology, but the scheme is not likely to come to much. They propose to build a metallic chapel and construct a captive balloon for conveying passengers from the foot of the rock to the top. M. Malte-Brun informed the Society of the creation in Brussels of a Belgian Geographical Society. The success of the recent scientific meetings held in that capital is regarded as a sure sign of the speedy success of the new institution.

A REPORT, dated New York, October 4, to the Secretary of the Liverpool Underwriters' Association, states that all the steamers arriving that week report large quantities of ice between lat. 45 and 46·30 N., and long. 49 and 50·30 W. One steamer passed two, one very large, about 200 feet high, "apparently aground;" another steamer passed forty-eight icebergs, and a third passed sixty-eight. It is certainly unusual to see so much ice at this time of the year so far south. We do not know whether the disaster to the Behring Sea whaling fleet can have any connection with this southward drifting of icebergs. Twelve out of fourteen vessels have been destroyed and many men. The cause of the disaster is not stated.

IT will be pleasing to ornithologists to know that there is every probability of the speedy appearance of the long-expected work by Mr. Gätke on the ornithology of Heligoland. The MS. for the German edition is already far advanced, and simultaneously an English one will be produced under the editorship of Mr. Henry Seebohm. It is probable that no more fit person could have been found for the task than the last-named gentleman, who has devoted himself to the study of European ornithology for many years past, and whose spirited energy in the expedition of last year to the Great Petchora, along with Mr. Harvie Brown, has rendered him famous among his brother naturalists. The practical experience gained by him during his journeys in Norway and in various parts of Southern Europe, will doubtless stand him in good stead in the by no means easy task which he has set before himself. At present he is staying in Heligoland, whither he was accompanied on a collecting trip by Mr. Bowdler Sharpe and Mr. Francis Nicholson, of Manchester. We learn from the latter gentlemen, who have returned to England, that in addition to the great interest attaching to the renowned Gätke collection, the short expedition proved a great success ornithologically, over eighty species of birds having been obtained or observed, among them being the rare *Phylloscopus superciliosus*, which was shot by Mr. Seebohm.

IN a letter dated "Labuan, August 17," Governor Usshe says that he has had great difficulty in getting specimens of the beautiful new pheasant recently described by Mr. Sharpe as *Lobiophasis bulweri*. He has twice sent over from Labuan to the mainland of Borneo the trained collector who obtained the original specimen, but hitherto without success. As, however, the birds are plentiful about thirty-five miles inland, he hopes to be able to get some examples very shortly. Bulwer's pheasant seems, in the north-western portion of Borneo, to be confined to

the Lawas River, where they are not uncommon, but on the Trusan and Brunei Rivers, which lie close to, the species is quite unknown to the natives, even by name.

THE Liverpool Geological Society held its first annual meeting of the session on the 10th instant, when the retiring president, Mr. T. Mellard Reade, C.E., F.G.S., delivered his annual address. The subject was an interesting one, being a calculation of the amount of solid matter removed annually from the surface of England and Wales in solution, in rain, or rather river water. The result of the calculations, which were of an elaborate nature, founded upon the analysis of water given by the Rivers' Pollution Commission in their Sixth Report, and the rainfall chart prepared by Mr. Symons, showed that it would take 13,000 years to remove, in this manner, one foot in depth of solid matter over the entire surface of England and Wales. This calculation was compared with others prepared by Mr. Reade, of the soluble denudation of the great river basins of Europe, viz., the Danube, the Rhine, and the Rhône. As throwing light upon the age of sedimentary deposits, the calculations taken, together with the amount of matter annually brought down in river water in suspension in the form of mud, are extremely interesting, and Mr. Reade deduced from them that the minimum amount of time which must have elapsed since the first sedimentary rocks we know of were laid down is, in round numbers, 500 millions of years, thus supporting the views of Lyell, Hutton, and other great geologists, as to the immense age of the world.

WE have on our table the following books:—"The River Clyde," by James Deas (J. Maclehose). Piddington's "Sailor's Horn-Book," 6th edition (Fredk. Norgate). "Spiritualism," Prize Essays. "Chemia Coartata; or, the Key to Modern Chemistry," Dr. A. H. Kollmyer (Churchill). Heer's "Primæval World of Switzerland," edited by James Heywood, 2 vols. (Longmans). Oscar Peschel's "Races of Man" (H. S. King and Co.). "Text-book of Veterinary Obstetrics," by George Fleming, Parts I. and II. (Baillière, Tindall, and Cox). "A Study of the Rhætic Strata of the Val de Ledro in the Southern Tyrol," by T. Nelson Dale. Three more volumes of Stanford's "British Manufacturing Industries."

FROM the 18th inst. numerous spots have been observed on the sun, and a large number of protuberances detected round the disc by means of the spectroscope. The observations have been made at Brussels by Monkhoven, and reported daily in the *Indépendance Belge*.

A NEW and enlarged edition of Hayden's "Dictionary of Dates" is in the press, bringing the book down to this autumn. It is being thoroughly revised and corrected under the hands of Mr. Vincent, of the Royal Institution.

MR. MURRAY will publish during this autumn, "A Life of Thomas Edward, A.L.S., a well-known Scotch Naturalist," by Mr. S. Smiles, author of "Self-Help." The book will contain a portrait etched by Rajon; "The Effects of Cross and Self-Fertilisation in the Vegetable Kingdom," by Charles Darwin, F.R.S., and a new edition of "Kirke's Handbook of Physiology," by Mr. W. M. Baker. In this book many chapters have been rewritten, and about 160 new illustrations added.

WE are glad to find that a second edition of Mr. James Geikie's work, "The Great Ice-Age," has been called for. A considerable number of alterations have been made, and some parts have been almost re-written. Daldy, Isbister and Co. are the publishers.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. M. Almond; a Grivet Monkey (*Cercopithecus griseo-viridis*) from North-east Africa, presented by Mr. T. T. Sich; three Palm Squirrels (*Sciurus palmarum*) from India, presented by Mr. Henry Grey; a Collared Peccary (*Dicotyles tajaçu*) from Venezuela, presented by Mr. C. J. Sims; a Greater-spotted Woodpecker (*Picus major*) European, presented by Mr. Henry Laver; a Magpie Tanager (*Cissopis leveriana*) from Brazil, purchased.

SCIENTIFIC SERIALS

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, t. xx. Nos. 3 and 4.—From these parts we note the following papers:—On an artificial way of producing snow crystals, by J. Dogiel.—On the appearance of Encke's comet in 1875, with remarks on the existence of a resisting medium in the celestial space, by E. von Asten.—On a remarkable motion observed in a very sensitive level, by H. Romberg.—On the property of the *sphagnum* of marshes, to absorb liquid water and water vapour from the atmosphere, by N. Geleznof.—On the determination of the brightness of fixed stars by means of Zoellner's photometer and gradual elevation, by Ed. Lindemann.—On pentamethylethol and its derivatives, by A. Boutlerow.—Diagnose of new plants of Japan and Mandshuria, by C. J. Maximowicz (tenth part; this treatise is in Latin).—On the mean curvature of planes, by Ferd. Minding.—Some observations on reflex movements, by J. Setchenow.—On three new pinacolines, by A. Wischnegradsky.—On some derivatives from lepidene, by N. Zinin.—On the calculation of the elliptical orbit by means of the two radii vectores r and r', of the angle $2f$ they enclose, and of the time t between the two observations of the planet, by M. Kowalski.—T. xxi. Nos. 1 to 4.—From these parts we note the following papers:—Researches on the rabbit (*Lepus cuniculus*), from a zoo-geographical and palæontological point of view, by J. F. Brandt.—Some observations on the sexual glands of insects, by Dr. A. Brandt.—On dimethylparabanic acid, and on succidcyanic ethers, by N. Mentschutkin.—On the orbit of the double star Σ 1728 = 42 Comæ Ber., by O. Struve.—On the observations of the planets at St. Petersburg, by A. Sawitsch.—Results of measurements made on dolomite, barytes, titan-iron, and zinc blende crystals, by N. Kokscharow.—Researches on blood, by H. Struve.—On some derivatives from lepidene, by N. Zinin.—Analysis of the coal newly discovered at Gelazk, in Imeretia, by Heinr. Struve.—On the remains of extinct rhinoceros found in Russia, by J. F. Brandt.—On a new siphon barometer, by H. Wild.—Some observations made based on the theory of primordial cellular leaves in the vegetable kingdom, by A. Famintzin.—On an anemometer provided with a simple apparatus to measure the force of the wind, by H. Wild.—On the transformation of some hydrocarbons in the ethylene series and the corresponding alcohols, by M. Boutlerow.—On the milky sap of *Cyanchum acutum*, L., by the same.—On diphenylcarbinol and some of its derivatives, by A. Zagumennoy.—Osmotic phenomena produced in vegetable and animal cells by the action of ether, by H. Struve.—On the curves of the smallest perimeter on surfaces of revolution, by Prof. Minding.—Speech delivered at a public meeting of the Academy on December 29 last, in praise of the late Prof. Jacobi, by H. Wild.—On the question whether the Karian sea can be looked upon as an ice-cellar, by K. E. van Baer.—Report on the memoir by M. Wex on the diminution of waters in sources and rivers, by MM. Helmersen and Wild.—Experimental Researches on some functional properties of the smaller brain, by Ph. Owsiannikow and W. Weliky.—Photometric researches concerning the diffused light of the sky, by H. Wild.—On the double star Σ 2120 = Herculis 210, by O. Struve.—On the action of zincethyl on acetaldehyde, by G. Wagner.—Additional remarks by K. E. van Baer, on the memoir on the law of the formation of river beds.—T. xxi., No. 5 contains only a few papers of interest. We note the following:—On the mineral substances containing paraffin in the peninsula of Apcheron, by H. Abich.—On the properties of Leuchtenbergite under the microscope, both in its pure and in its metamorphosed state, by Duke Nikolas, of Leuchtenberg.—Microscopical properties of the Indian green aventurine, by the same.—On the chemical composition of dialurates, by N. Menschutkin.—On the morphology of *Ulothrichea* (a genus of *Algæ*), by L. Cienkowski.

Revue des Sciences Naturelles, tome v. No. 1.—In this number M. Collot carries out in the plant-kingdom a line of inquiry that has been prosecuted in the animal. He shows that many plants before reaching their final form pass through forms very different from that; these young forms lack special character and show the average and most common conformation of the group to which the plant belongs (Australian Acacias, &c.), or serve to

connect the most numerous species of a genus with species which have exceptionally retained in a permanent way the original arrangement (flax). They are more remarkable the greater the differentiation of the adult with reference to neighbouring groups (pines); and the order of appearance of fossil forms in strata is the same as the succession of forms in the same individual.—In a paper on absorption of bicarbonates by plants, M. Barthelemy finds that in natural waters, plants absorb more water than bicarbonate except when rapidly dried or in the flowering season. The quantity of bicarbonate absorbed, for the same absorption of water, varies with the nature of the plant. At night and in water saturated to the same degree, plants excrete a part of the bicarbonates absorbed during the day. The roots of plants give back carbonic acid, which maintains the bicarbonates saturated.—There are also papers on the development of insects, and on development of the embryo of *Nelumbrium speciosum*, and M. Bechamp, in a lengthy paper, attacks the doctrine of evolution.

FROM the *Naturforscher* (August, 1876) we note the following papers:—On the physical condition of Saturn, by L. Trouvelot.—On the spreading of drops of liquids into thin layers, by F. Cintolesi.—On a new fundamental law in electro-dynamics, by Prof. Clausius.—On the natural means of protection of flowers against their animal destroyers, by Herr A. Kerner.—On the action of light upon the electric behaviour of metals in water, by W. Hankel.—On the influence of shape upon the magnetism of soft iron cylinders, by Dr. Christoph Ruths.—On the phenomena of motion and electricity in the leaf of *Dionæa muscipula*, by Herr Hermann Munk.—On the magnetism of cobalt and nickel, by W. Hankel.—Phenomena of interference of light passing through two dimmed planes, by K. Exner.—On allotropic states of gold, by Julius Thomsen.—New inorganic cells, by Ferd. Cohn.—On the influence of gravitation upon the development of adventive roots and shoots, by L. Kny.—On the theory of the optical power of crystals of turning the plane of polarisation of light, by Herr Sohncke.—On the physical nature of the sun, by Herr O. Lohse.—On the diffusion of gases by absorbing substances, by S. von Wroblewski.—On electric light, by Herr E. Goldstein.—Further researches on the peptone-forming ferments in the vegetable kingdom, by E. von Gorup-Besanez and H. Will.—Arrangements for the protection of chlorophyll in living plants, by Julius Wiesner.

Mittheilungen der naturforschenden Gesellschaft in Bern, 1875, Nos. 878-905. From these parts we note the following papers: On the changes of generation in the animal kingdom, by J. Fankhauser.—On some observations of the sources and wells in the district of Bern, during the years 1872-4, by R. Lauterburg.—Topographical sanitary notes on the same district, by Dr. A. Ziegler.—On a multiple telegraphing apparatus, by Herr Rothen.—The greatest part of the publication is taken up by a very elaborate list of the plants growing in the Berner Oberland, by Prof. L. Fischer.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 16.—Vice-Admiral Paris in the chair.—The President referred to the sad loss sustained by the Academy in the death of M. Sainte-Claire Deville, and M. Dumas spoke on his life-work. The following papers were read:—Intra-Mercurial planets (continued), by M. Le Verrier.—Exploration of the whole of the coast which forms the gulf of the two Syrtes, by M. Mouchez. The extent of coast surveyed is 200 leagues. The work was difficult, owing to the nature of the land (banks and dunes of sand) and the hostility of the natives. This work fills the gap left by English hydrographers, who had stopped at Sfax, the last town of Tunis, and resumed at Benghazi, on the Egyptian frontier.—Itinerary of the double voyage of M. Nordenskjold between Norway and Siberia, in 1876, in the *Eymer*, by M. Daubrée. The rapidity of this voyage is striking, twenty-four days from Norway to the mouth of the Jenisei and eighteen days home.—On the relation of the two specific heats of a gas, by M. Simon. *Perfect* gases are those which follow the laws of Mariotte and Gay Lussac. *Simple* and *tetratomic* gases are those whose molecules are formed of four smaller molecules, all alike, which may be treated as atoms (such appear to be hydrogen, oxygen, nitrogen, &c.). In such a gas he imagines the four atoms to occupy the summit of a regular tetrahedron, the side of which is greater than the diameter of any of them, and the interior of this tetrahedron filled with free or condensed ether. Taking account of the rotation of each elementary tetrahedron about its centre of gravity and regarding the vibrations of the atoms as *nil* or insensible, he has found the ratio of the two specific heats exactly $\frac{7}{5}$, or 1·40; while experiment gives values between 1·39 and 1·42. Hence may be inferred that the interior vibrations are really negligible, and in simple gases the physical molecules seem to remain sensibly invariable, so long as no electrical or chemical phenomena are produced.—Note on the presence and origin of Phylloxera in Orleans, by M. Mouillefert. There are facts to show that in advancing towards the northern limit of cultivation of the vine, the phylloxera is less rapid in its action; still the vine is none the less doomed to certain death; it is only a question of time.—Remarks on a recent note of M. Lichtenstein, on the reproduction of phylloxeras, by M. Balbiani.—Study of comparative analyses of several varieties of American stocks, resistant and non-resistant, by M. Boutin. He has found in all American stocks a resinoid principle; it exists also in French stocks, but in quantity a half less than in the resistant American stocks, and a third less than in the non-resistant. He accounts for the resistance by presence of this principle in a proportion not under 8 per cent. in the entire root, and 14 to 15 per cent. in the bark alone. The prick made by the insect, while causing nodosities on the root, is cicatrised by exudation of the resinous product; and this prevents loss of the nutritious juices of the plant. No such cicatrisation occurs in the non-resistant stocks, the resinous matter not being abundant enough. Perhaps the malic acid in the roots of American vines also contributes to their resistance.—Note on the velocity of propagation of waves, by M. Laroche.—On the chiselling action of acids on various metals, by MM. Trève and Durassier. The figures produced are in relation, not with the interior structure, but with the exterior action of bubbles of gas liberated during the reaction of the acids.—Combination of chloral and acetic chloride, by MM. Curié and Millet. Heated to 100° they unite (about half of the two bodies after twelve hours' heating); there is one molecule of each, and the bodies are simply juxtaposed. Subjected to nascent hydrogen, the body loses two atoms of chlorine and gives a new compound, which may be considered acetic chloride united with monochlorised aldehyde.—On a sulpho-antimoniuret of lead found at Arnsberg (Westphalia), by M. Pisani.—Observations on the origin of eruptive, vitreous, and crystalline rocks, by M. Lévy. His experiments are against Meunier's view that crystalline rocks are derived from vitreous rocks by way of devitrification. Most natural crystalline rocks owe their internal texture to *promorphic* phenomena, that is, phenomena anterior to their consolidation; secondary actions are also important, but they rarely quite mask the original texture of a rock.—On the comparative influence of leafy woods and of resinous woods on the temperature and ozonometric state of the air; consequences as regards climate, by M. Fautrat. Woods of both kinds have a refrigerant power, more marked in the resinous. The phenomena of assimilation and transpiration in leaves are accompanied by a fall of temperature. Above pines the maximum temperatures are always higher, and the minimum always lower, than outside; the phenomena lowering temperature on leafy trees are masked in pines, by others producing heat. Under woods, especially the resinous, there is less ozone than on open ground.

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